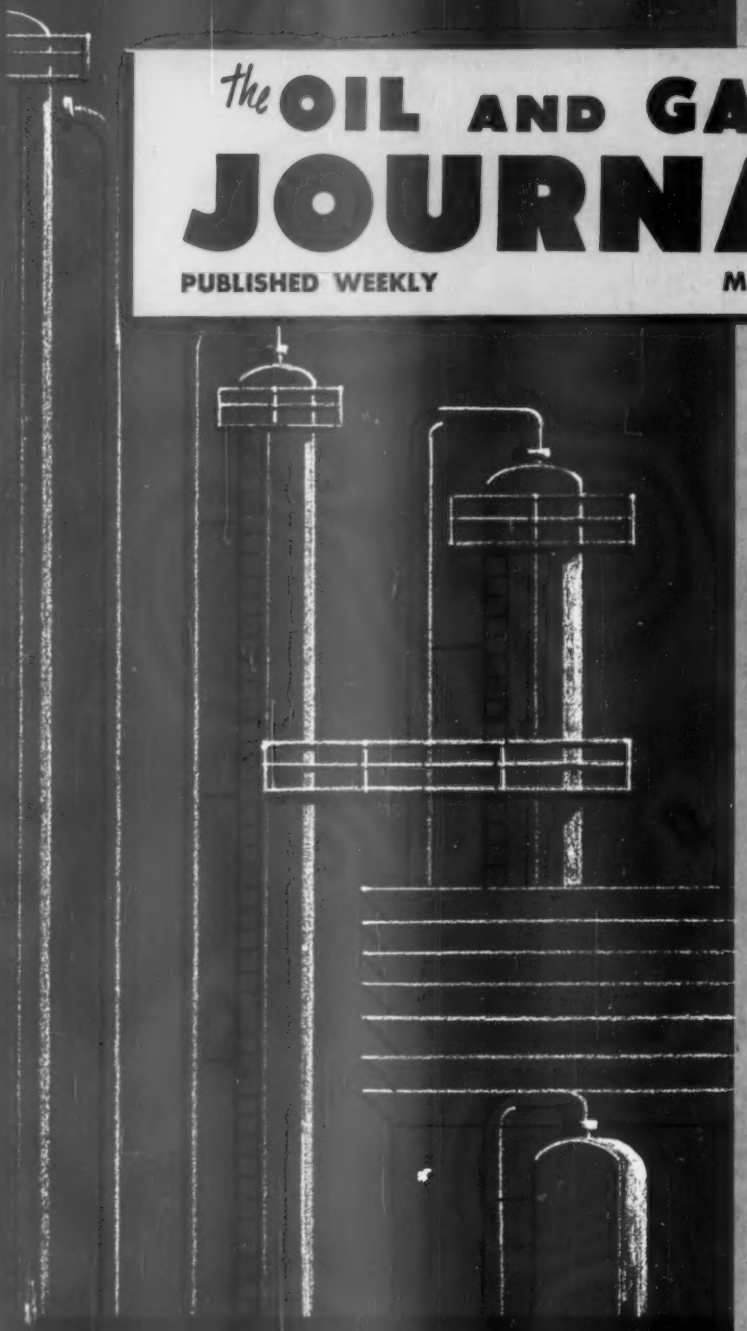
the OIL AND GAS JOURNAL
PUBLISHED WEEKLY May 2, 1960

AP PIPELINE REPORT p. 153



FIELD PROCESSING

A special issue featuring the Journal's annual survey of natural-gasoline plants and selected NGAA papers.

p. 94

Standard of California jilts ethyl for methyl p. 74

Ten-year oil outlook good, N. Y. banker says p. 76

Offshore operations are $1.8 billion in the red p. 78

Engineering details of first quintuple completion p. 149

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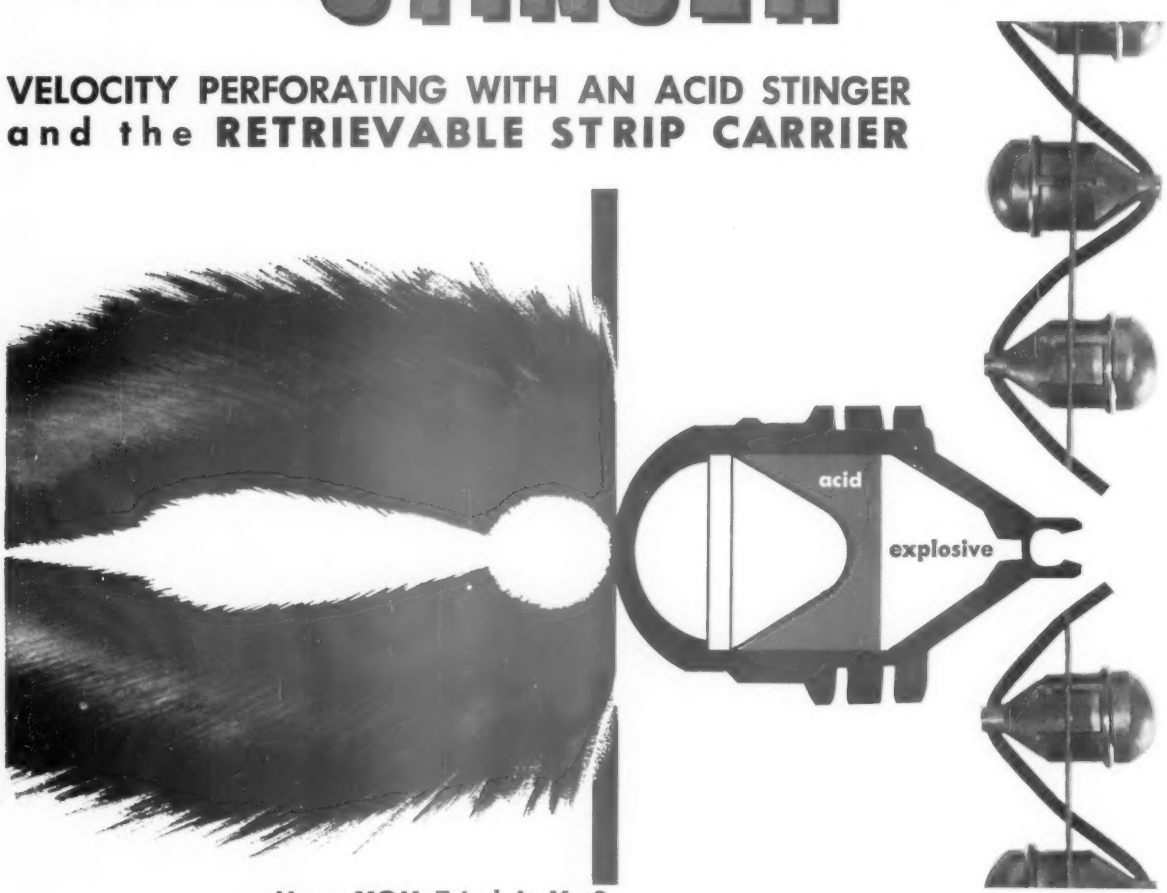

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OIL AND GAS JOURNAL
Vol. 58, No. 18

Contents May 2, 1960

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The Oil and Gas Journal is published weekly by The Petroleum Publishing Co., 211 S. Cheyenne, Tulsa 3, Okla. Second-Class postage paid at Tulsa, Okla. Copyright 1960 by The Petroleum Publishing Co. United States and foreign rates to the petroleum industry, 1 year $5, 2 years $8, 3 years $10.

Annual Field-Processing Report

New Graphical Method Simplifies Absorber Design 94
By S. H. Landes and F. W. Bell

Using the new method reduces tedious calculations to 2 to 3 hours' time.

Transfer Hose Can Cause LPG Contamination 99
By C. W. Mullins

Natural-Gasoline Plant Automation Survey 100
By John L. Ryan

Industry replies to NGAA questionnaire show extent of automation, type of equipment, and where it is used.

New Enthalpy Data for Light Hydrocarbons 104

A resume of compounds and mixtures which have been investigated and the extent to which they have been studied.

Annual Survey of Field-Processing Plants in the U. S. 107

For the first time, the Journal presents a complete list of products from every plant in the U. S. Companies have reported an average production of 41,180,-713 gal. of liquids daily for 1959. The survey is in two tables, natural gasoline and cycling.

Annual Survey of Field-Processing Plants in Canada 135

A plant-by-plant report on field processing in Canada shows liquid production at nearly 1,000,000 gal. daily in 1959, with current capacity at 1,554.7 M.M.c.f. daily.

40 New Field-Processing Construction Projects Reported 137

Here is an up-to-date rundown on new plants and expansion projects in the U. S. and Canada. Most of them are scheduled for completion by January 1, 1961.

Planning for Mined Underground LPG Storage 141
By S. E. Scisson

This type of storage can be built for $3 to $4 per barrel of capacity in suitable geological formations.

Technology—Operation

Refining Cost Indexes 103

First Quintuple Completion Was Fast and Certain 149
By Ed McGhee

Successful job is evidence that multiple-string completions can be carried out by running strings simultaneously.

Internal Coating Boosts Pipeline Gas Flow 177
By C. H. Klohn

API Pipeline Report

Handling Transient Pressures in Long Pipelines 153
By Richard R. Burnett

Methods have been developed to predict and control high-pressure traveling waves in a long pipeline.

Digital Simulation of Crude-Oil Pipelines 161
By T. R. Young

Automatic-control simulation, two-phase flow design, hydraulic representation of a multistation pipeline (including line profile), operation of a heated oil line, and optimizing power costs are operations which can be handled by a computer.

The OIL AND GAS JOURNAL Newsletter

Tulsa, Okla.
May 2, 1960

Oil explorers are still turning up big discoveries:

Two major oil fields in Venezuela were announced last week by Gulf Oil Corp.

Three wells in South Cueta field in Lake Maracaibo are extremely productive with pay thicknesses up to 1,100 ft. Field is on eastern side of the midlake area on Lot V-575, east of Block 11. Wells are six-tenths of a mile apart.

Two wells in La Ceiba area in Eastern Venezuela state of Anzoategui have been completed with 700 ft. of oil and gas sands.

Both South Cueta and La Ceiba fields are deep—10,000 to 15,000 ft. Through subsidiaries, Gulf has half of the production with other half split equally between Shell and Jersey Standard.

Two stepout producers have been reported for Paria Operations in the Gulf of Paria. Both are stepouts for Posa 1.

The first was good for 200 bbl. daily and the second for 600 bbl. daily.

Mobil is first American firm to share a strike in Algeria (p. 91).*

Its joint-interest wildcat, the 1 Ohanet, tested at rate of 1,900 bbl. daily through 1-in. choke at about 7,740 ft. Location is 350 miles south of Mediterranean and 30 miles west of a 460-mile, 24-in. crude line being built to coast of Tunisia from Edjele, Zarazaitine, and Tiguentourine oil fields.

Mobil considers the strike important because it gives the company a source of French community crude for its two French refineries. Firm also has finds in Libya and Tunisia.

▼ ▼ ▼

First serious, concentrated look at the Atlantic Coastal plain as possible source of oil was taken at Atlantic City session of AAPG (p. 73).

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*Refers to article in this issue giving more details. Where no page is given, the item is a Newsletter exclusive.

Region was termed likely target with chances good but risks high. More drilling is needed to produce more subsurface dope.

The conclusion: Only by tracing subsurface knowledge to the surface, by intensive geophysical work, and by drilling more wells will the industry find elusive Atlantic oil.

Labor and steel are the culprits in the high cost of drilling, says IPAA's cost-study committee.

Its rundown: Rock bits dropped in price in 1958 and again last year...Drilling mud price also declined in 1958, failed to rise last year...Contract services and equipment costs rose only slightly.

But a sharp jump in labor costs and casing prices, the committee says, forced up total costs for the 10th consecutive year. Average well costs last year: 166% of the 1947-49 base period.

The payoff is still years away even after 14 years of oil searching in offshore waters of the Gulf.

Despite the phenomenal success of the search, the oil industry is still $1.87 billion in the red. There are signs that operations may edge into the black soon. But the day when total investment will be recovered is still far in the future. This is the estimate of an offshore pioneer, Ira H. Cram, senior vice president of Continental Oil (p. 78).

▼ ▼ ▼

IPAA is teaming up for new fight to trim imports.

The independent producers at Denver convention were nearly unanimous in one opinion: The present economic plight of producing industry demands further import restrictions.

But Washington appears satisfied with present curbs. Imports Boss Carson, in fact, told IPAA real culprits for depressed oil business are natural gas, coal, refiners who weaken markets by making too much products, and state regulatory officials (p. 77).

Oil's outlook has changed since last October—demand will be up this year but not as much as IPAA expected.

The association's supply-demand committee now forecasts an increase of 2.9% or 274,000 bbl. daily this year. This is roughly 100,000 bbl. daily under the October forecast (p. 80).

Changed outlook is due to poor fourth quarter last year, failure of demand to bounce back fast in 1960 first quarter. The trouble is the increase can be met from inventories without any increase in crude production.

Speaking of production, note that Kansas joined the list of prorated states cutting May allowables by reducing production 25,000 bbl. daily...Louisiana made good its plan to cut by setting May and June allowable at 938,170 bbl. daily, 38,983 bbl. daily under March-April level.

The longer outlook may be better for oil, says the oil economist for the First National City Bank of New York.

He says continued demand growth over the next 5 years will mop up nearly all the present world-wide surplus. And during the second half of this decade talk of an oil and gas shortage should not sound too much out of place (p. 76).

▼ ▼ ▼

Gasoline demand is surprisingly good.

Weekly figures show total gasoline demand exceeds 4,000,000 bbl. daily for each of the last 4 weeks. It topped 4,500,000 bbl. daily last week. Last year such a volume wasn't reached until the last of June (p. 237).

First methyl motor fuels are being offered American motorists at pumps in California Standard stations.

Company is replacing tetraethyl lead with tetramethyl lead in its premium gasolines and will use both in regular and superpremium fuels.

Standard gave this reason for switch: Tests over 2.5 million miles of road service show TML is more effective anti-knock agent for today's gasolines (p. 74).

▼ ▼ ▼

Projects on the shelf:

Shale-oil process plans of Union Oil Co. have been dropped. The Rifle, Colo., retort will be dismantled.

Company blames combination of low depletion allowance for shale oil and depressed crude prices for decision (p. 73).

Underground nuclear blast to tap the riches of Athabasca tar sands will be delayed at least 2 years, Ottawa report says.

Reasons: General dislike now for atomic tests and disagreement on safety aspects of tar-sands blast.

▼ ▼ ▼

Connole apparently is definitely going off the FPC.

President Eisenhower told newsmen flatly the reason why the present commissioner won't be reappointed: The President thinks he can get a better man, that's all.

Eisenhower's choice at the moment is Harold I. Baynton, 56, an attorney from Nevada, who has been in federal government work for more than a decade. He has no regulatory agency background.

Better methods of cost control—rather than the usual operating and engineering advances—got top billing last week at API pipeline conference in Tulsa.

Other program spots went to public relations, right-of-way problems, and automation (p. 153 for technical reports).

Market Memo

May 2, 1960

Gasoline is the best buy in the low-priced field today. It's a buyer's market, for supply exceeds demand.

And keep in mind, when spot prices are weak, they undermine the market and become lower posted prices. Most posted product prices in a buyer's market are as phoney as a $3 bill. From spot product prices, posted crude-oil prices are derived.

The exact level of product prices in any market, at any point in time, is the result of competition for business between suppliers in that market. (See p. 237).

Gulf Coast spot gasoline is weak at one-half cent to three-quarters off posted prices for prompt lifting...No. 2 is in good bargaining position at three-eighths to one-half cent off for spot prompt cargoes, but not more than three spot cargoes are available at this price. East Coast No. 2 contract buyers are negotiating for next winter's supply on premise that No. 2 will go up before it goes down in price. ...No. 6 price on Gulf of $2.10 per barrel will not bring out prompt cargoes.

Mississippi River product prices are lousy. Gasoline at midriver terminals is weak at one-quarter to one-half cent off Gulf Coast posted lows. Buyers can start loading their barges with gasoline at this price range...Midwest No. 2 is priced at one-eighth to one-quarter cent off posted price in an unseasonal demand period.

Confucius say: "Gulf Coast gasoline is blocked out of Midwest by river prices."

Group 3 gasoline prices are in shock as result of an independent refiner's quoting one cent per gallon off the posted 11-cent price in an effort to move gasoline. Interrefinery spot price on this 91-research octane gasoline is three-quarters off posted price or at 10.25 cents per gallon ...Group 3 distillates are as listless as central heating units in the summer and priced at one-quarter cent off posted.

Chicago prices are rough too. It's an untouchable market from river sources of supply. Gasoline of 92-research octane posted at 11.625 is available at one-quarter cent off the published price...Commercial consumer market is the battleground, with 92-RON gasoline getting 10.85 cents per gallon up, subject to change without notice...Middle distillate prices are unnoticed at one-quarter cent off postings.

Crude-oil prices are weak—except in Pennsylvania-grade areas. Crude is selling mostly in an 80%-prorated, 8-day Texas allowable market for May...South Penn has posted a 15-cent increase on Pennsylvania-grade crude, making the new top $4.70 per barrel in the Bradford district.

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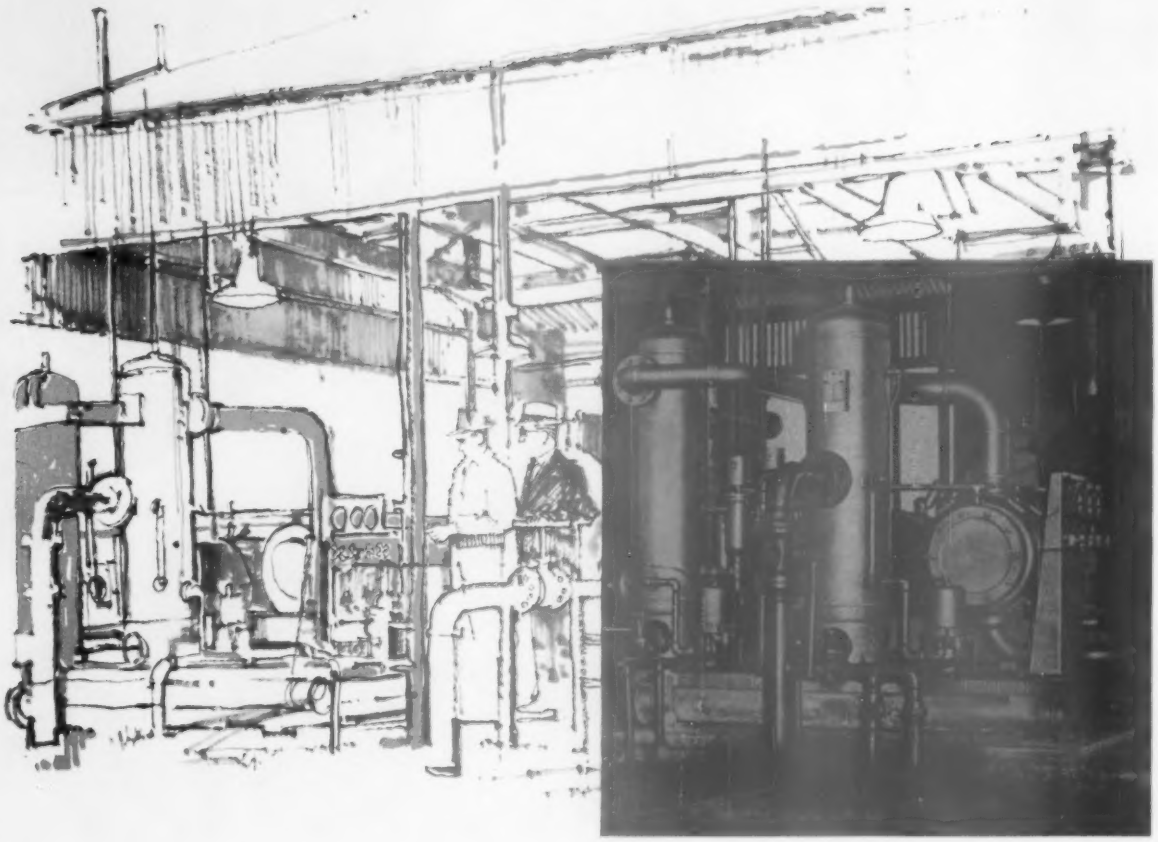

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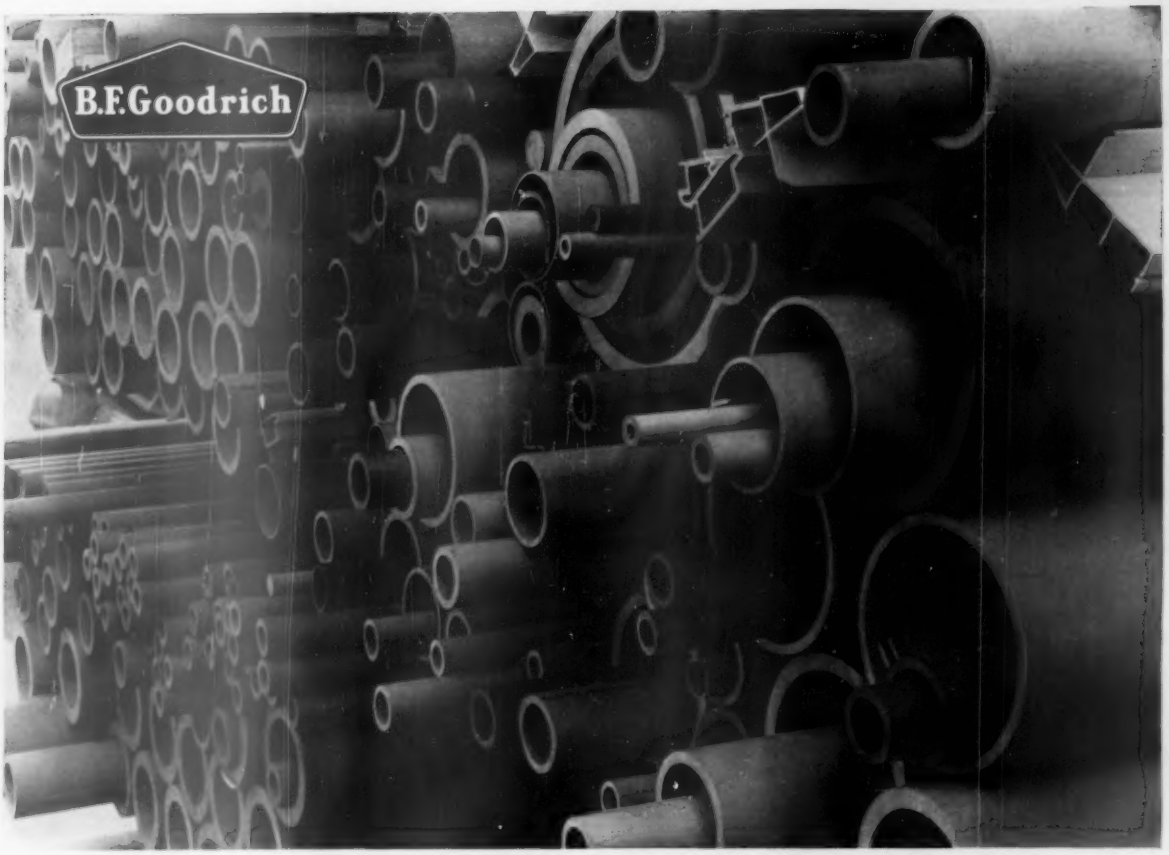

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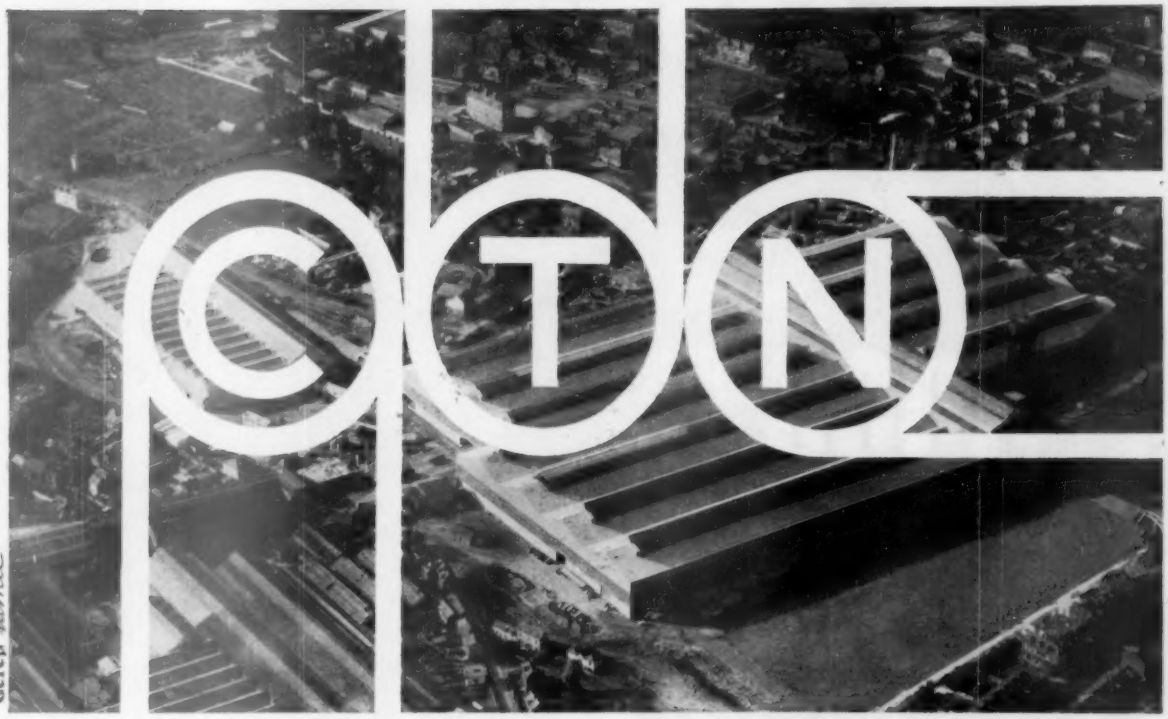

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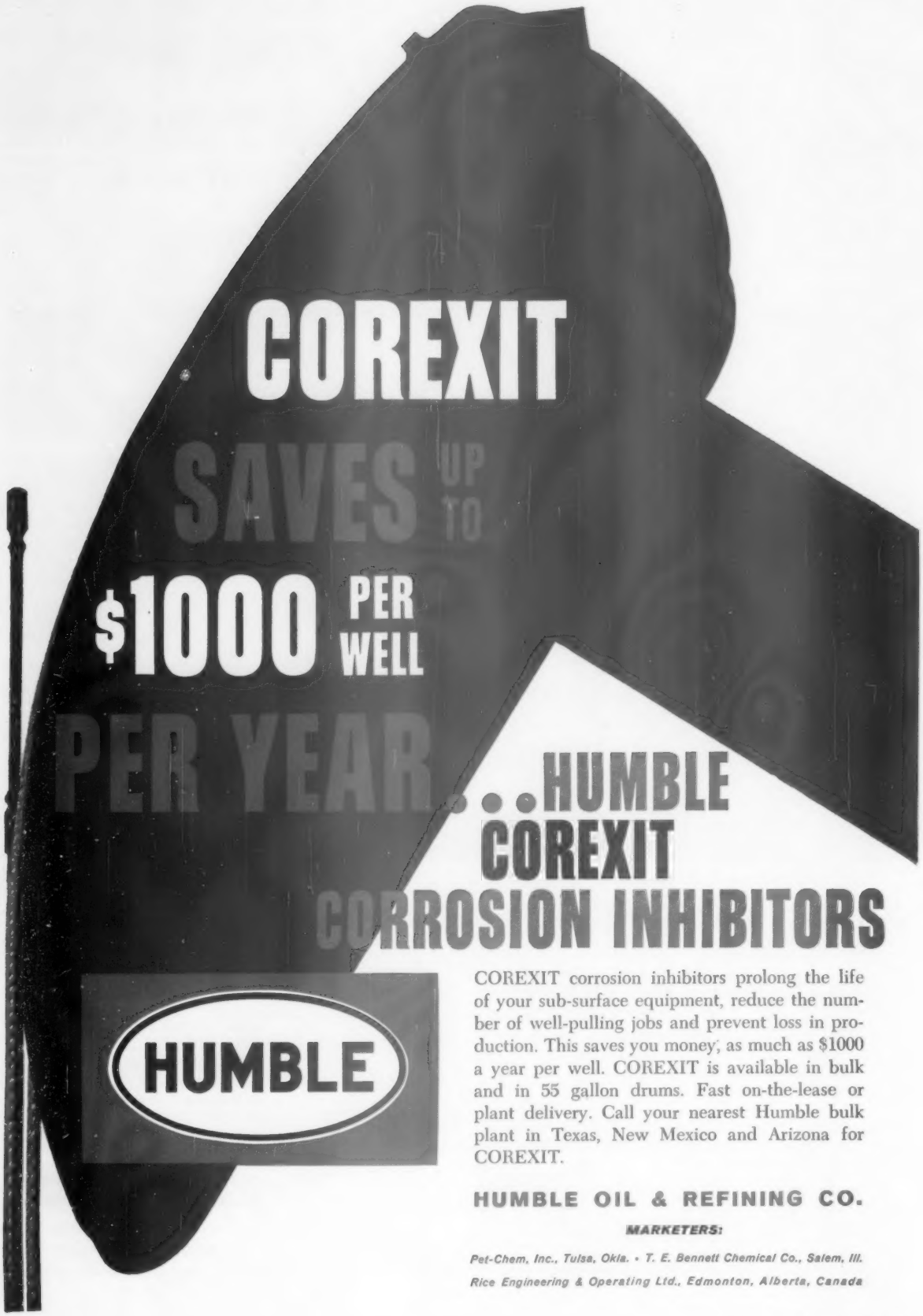

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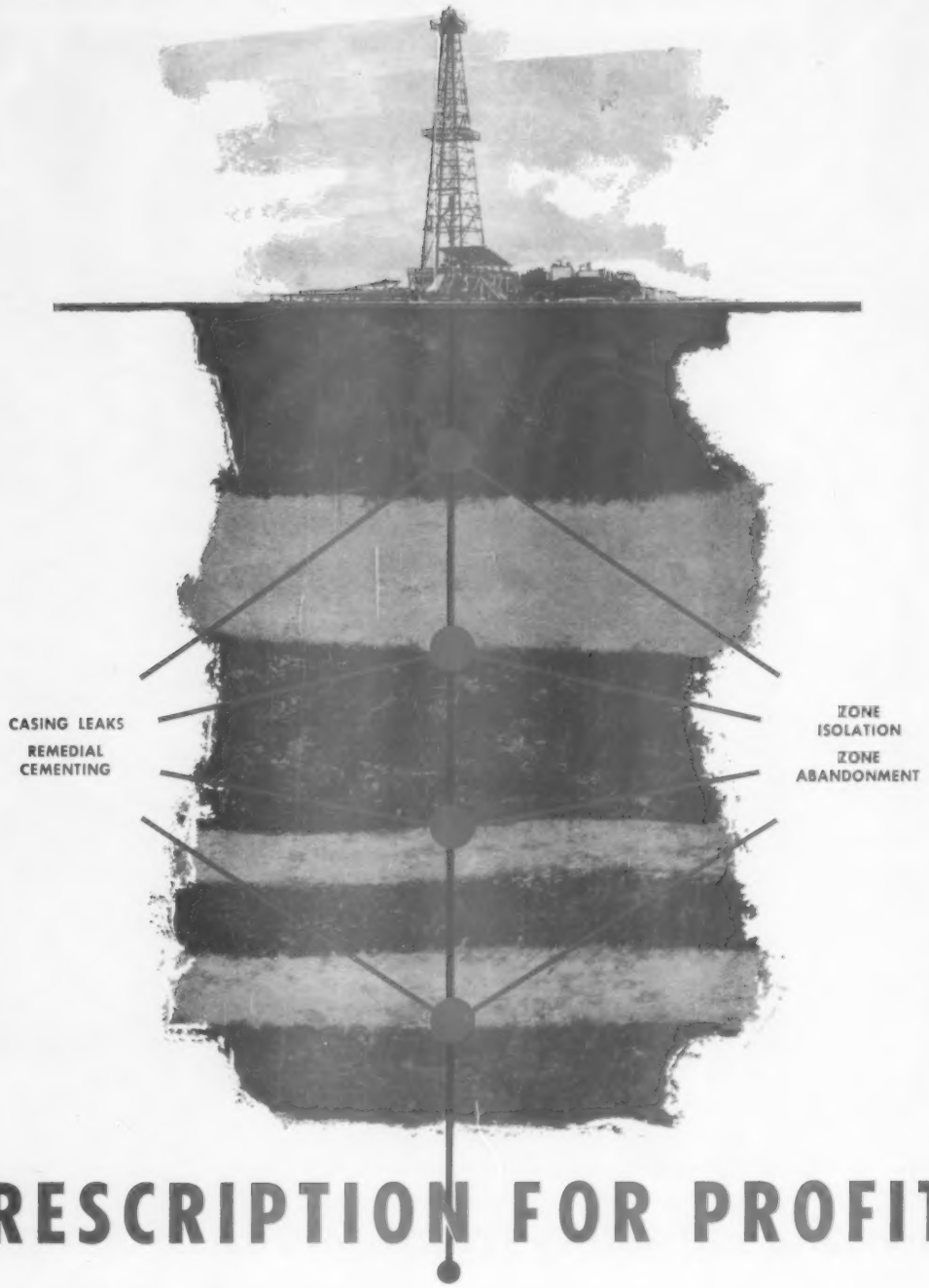

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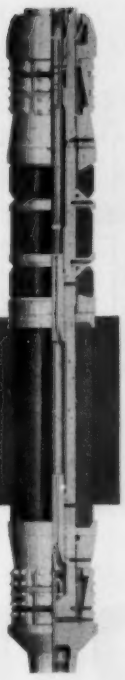

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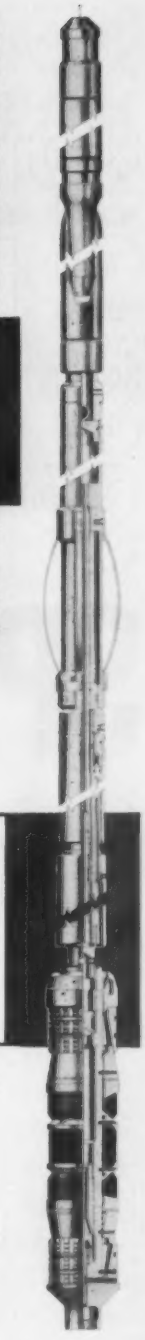

WIRE LINE HYDRAULIC SETTING TOOL ... can be used to set a "DM" and "DC" Squeeze Packer or a Wire Line Bridge Plug from a sand or drilling line. It may be run in a well with or without fluid since the tool carries its own operating fluid. A few short upward strokes with the wire line operates the hydraulic pump inside the tool to build up pressure adequate to shear the pins, set the slips, expand the packer rubbers and part the tension sleeve. Setting tool is then free for removal from well before service job begins.

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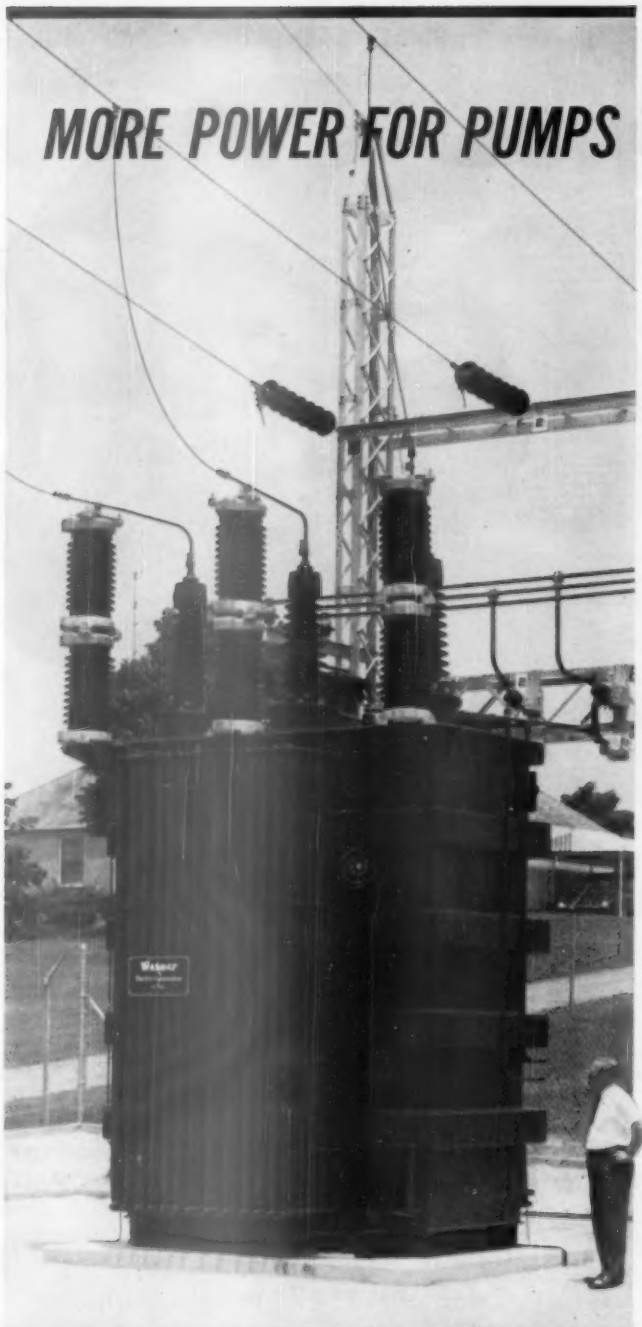
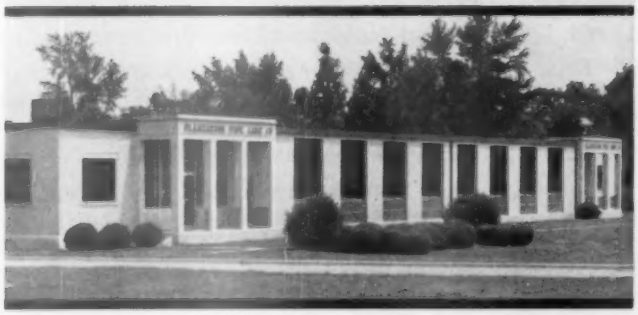
CONSOLIDATED CHEMICAL INDUSTRIES DIVISION, 6910 Fannin St., Houston 25, Texas

75 YEARS OF SERVICE TO INDUSTRY AND AGRICULTURE 1900 1965





MORE POWER FOR PUMPS THAT PUSH PETROLEUM

THIS WAGNER TRANSFORMER

POWERS-UP

PLANTATION PIPELINE

The Plantation Pipeline Company pumping station at Neese, Georgia, is part of an underground transportation system that pushes high quantities of petroleum products to their market.

The Neese operation was originally served with power from a 44 kv system substation. However, the size of the pumping load—which includes some 1800 hp motors—became too great for the substation to handle adequately.

To better serve the load, Georgia Power Company recently installed a 110 kv line and built a new substation. Wagner Electric Corporation furnished the transformer rated at 7500 Kva for this purpose. Today, Plantation Pipeline pumps with full power.

Now, what about your power needs? If they present a critical (or even a potential problem), call your nearby Wagner Sales Engineer. He'll help you plan your power program . . . suggest Wagner transformers that will meet your needs for years to come. There are Wagner branches in 32 principal cities.

Wagner Electric Corporation

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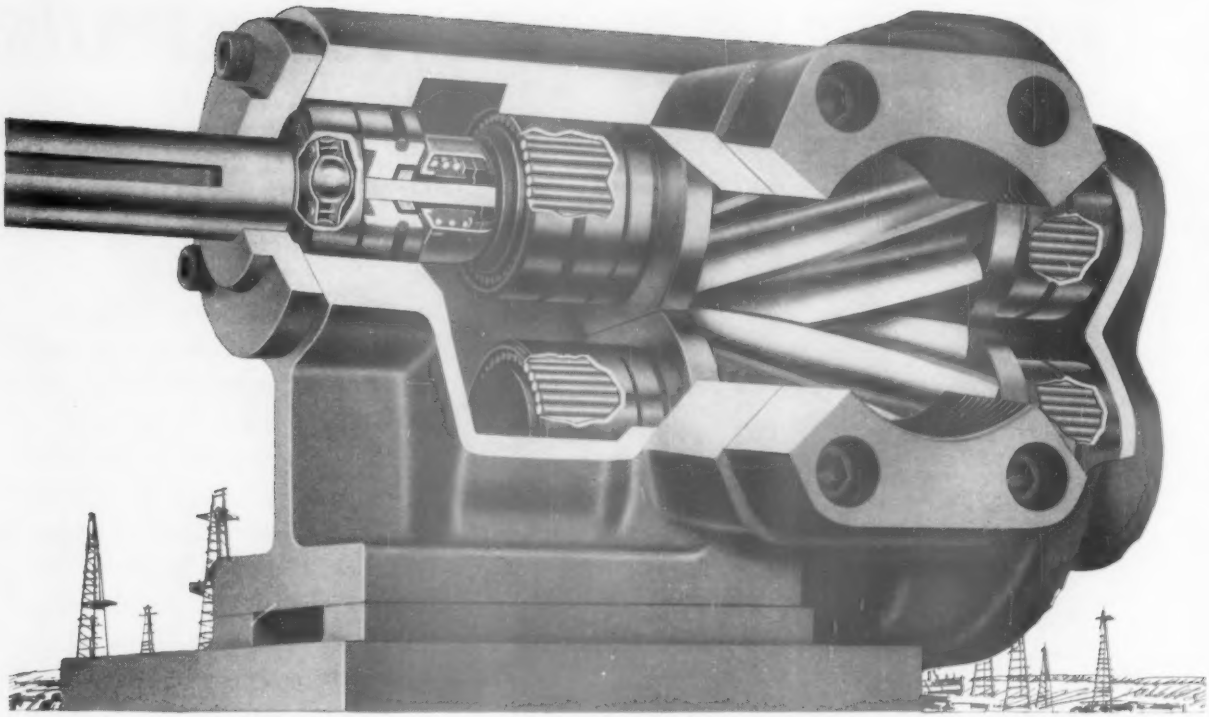
WT60-8

SERVING 2 GREAT GROWTH INDUSTRIES—*ELECTRICAL • AUTOMOTIVE*



New B&S "300" series rotary gear pumps. For pressures to 300 psi; caps. of 40, 60, 85, 125, 170 gpm.

Now from Brown & Sharpe,

a brand new line of designed specifically for

Born of intensive research with petroleum engineers and field personnel, these new B&S rotary pumps bring you twelve big, clear-cut advantages

1 Standard pipe connections fit 1", 2", 3" or 4" pipe directly, without extra fittings.

2 Inlet and outlet are same size.

3 Replaceable pipe flanges can be quickly changed to match pipeline size – eliminate pump replacement caused by damaged threads. Threads are in flanges only – not in pumps.

4 Standard bolts and screws and fewer parts make B&S pumps easier to maintain.

5 Replaceable wear plates protect rotating elements. You replace plates after normal wear. not pumps.

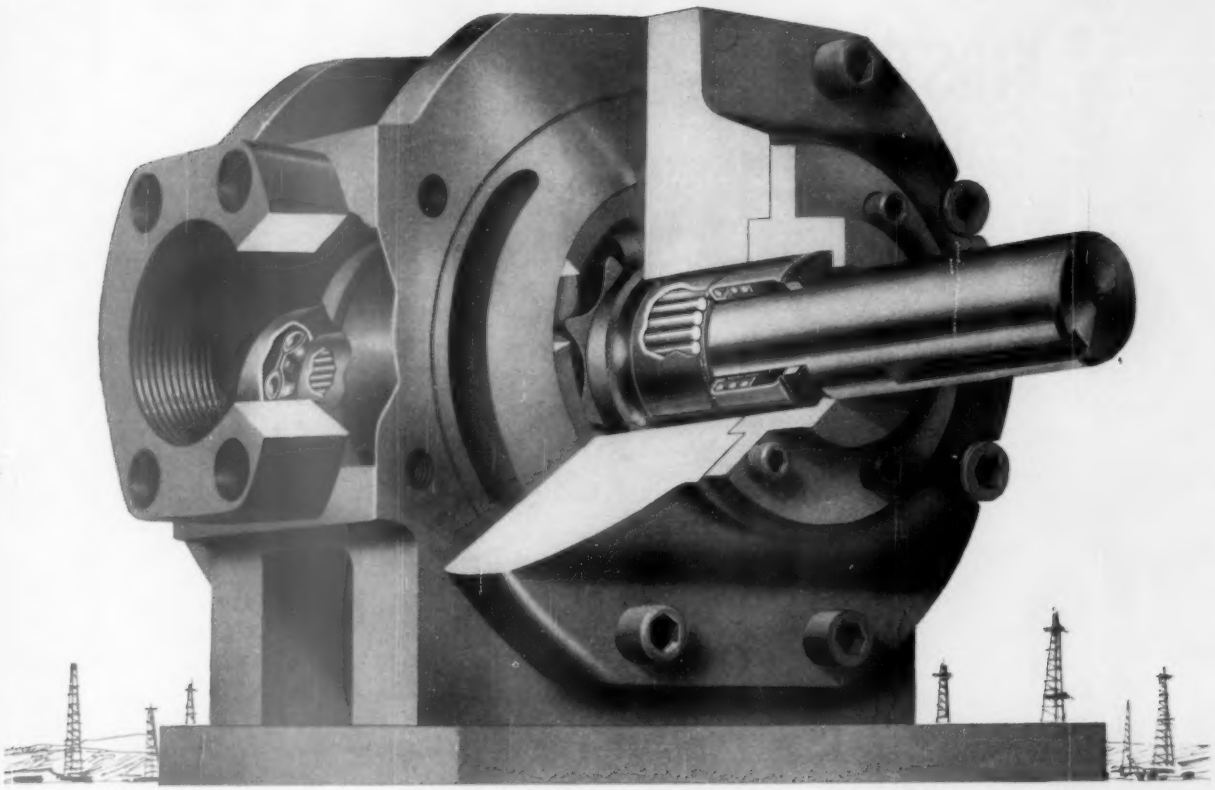
6 Roller bearings standard equipment.

7 Low inlet velocity prevents cavitation.

8 Standard outside dimensions help assure convenient replacement for other pumps.

9 Uniform quality and dependability assured by Brown & Sharpe's 90 years of pump-making experience; by Brown & Sharpe's traditional quality controls and precision.

10 Field tested — These new B&S pumps have been put to work in the Petroleum Industry – and have proved every bit as efficient and reliable as intended.



New B&S "700" series gerotor pumps. For pressures to 1000 psi; caps. of 20, 30, 40, 60, 80 gpm.

rugged rotary pumps the petroleum industry

11 Longer life is assured by fine finishes, roller bearings and wear plates in all B&S Pumps. Here, in the efficient "gerotor" high pressure pumps, an inner element of 4 "teeth" drives

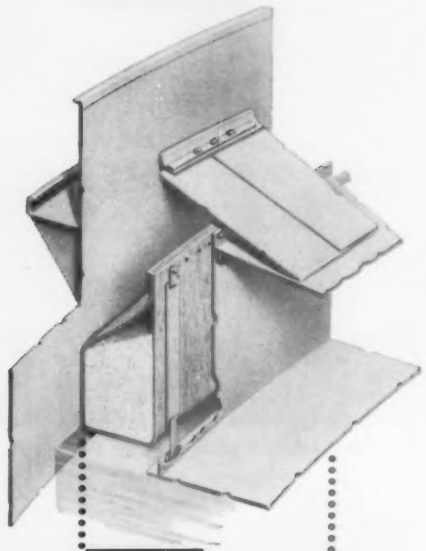
outer element of 5 "teeth"—forming a continuous, rolling, fluid-tight contact that progresses in the same direction. Fluid is picked up by chambers "opening" over a suction port in one half of the pump — squeezed out at a pressure port in the other half. Wear is very low because the speed between elements is only 1/5 driven speed.

12 Readily available to you, through your nearest oil field supply house.

You will save money with these new B&S Pumps because they install faster . . . are easier to maintain . . . have an extra-long service life. Contact your oil field supply house for a catalog. Or, write Hydraulics Div., Brown & Sharpe Mfg. Co., Providence 1, Rhode Island.

Brown & Sharpe PRECISION CENTER

FIRST solid cushion seal



When General American developed EverSeal, first solid cushion seal for floating roofs, we wanted a seal that would have these advantages:

1. Simplicity of design, no moving parts, nothing to corrode
2. Permanent, indestructible sealing qualities—no gas or liquid to leak
3. Complete protection of coated tank walls from scuffing or gouging
4. A tough, pliable envelope that would withstand abrasion; ride without damage over projections on the shell
5. Ease of repair or replacement, without taking tank out of service
6. Maximum protection against evaporation loss
7. Full protection of oxygen-sensitive stocks
8. No build-up of vapors in the seal area

EverSeal is the *first* solid cushion seal to meet *all* these requirements. It is made of trapezoidal urethane foam cushions enclosed in a tough, scuff-proof envelope of Buna "N" synthetic rubber and polyvinyl chloride plastic.

EverSeal is almost impossible to damage, always provides a safe and complete seal for every floating roof.

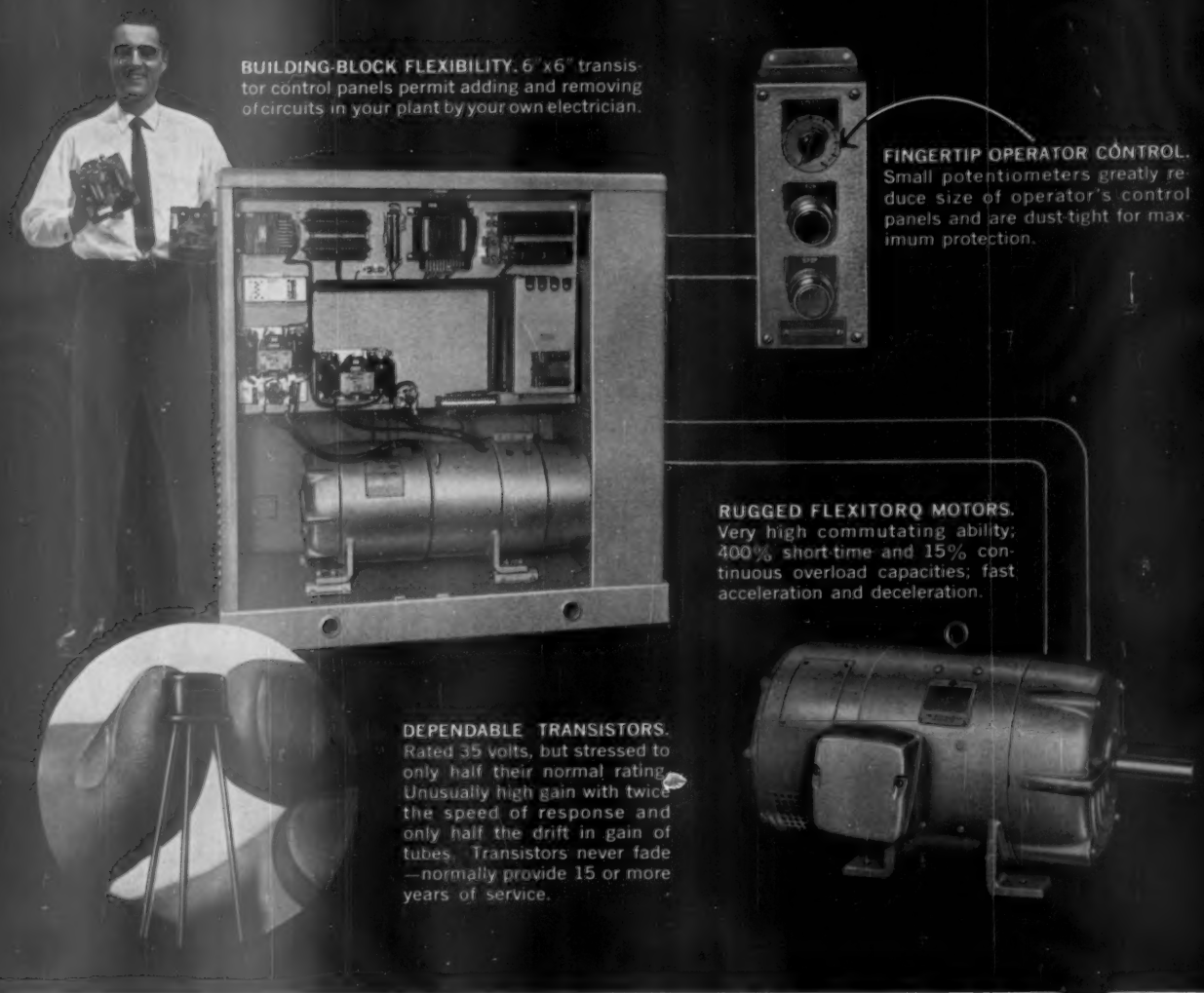
Write or phone your nearest General American office for complete information.

It pays to plan with General American.

EverSeal*

*Patent Rights Reserved

by General American


BUILDING-BLOCK FLEXIBILITY. 6" x 6" transistor control panels permit adding and removing of circuits in your plant by your own electrician.
FINGERTIP OPERATOR CONTROL. Small potentiometers greatly reduce size of operator's control panels and are dust-tight for maximum protection.
RUGGED FLEXITORQ MOTORS. Very high commutating ability; 400% short-time and 15% continuous overload capacities; fast acceleration and deceleration.
DEPENDABLE TRANSISTORS. Rated 35 volts, but stressed to only half their normal rating. Unusually high gain with twice the speed of response and only half the drift in gain of tubes. Transistors never fade —normally provide 15 or more years of service.

The New LOUIS ALLIS Select-A-Spede® Drive —First with field-proved All-Transistor Control

a high-gain, high performance d-c drive with unmatched flexibility and low upkeep

Here's a superior adjustable speed drive with simplified transistor-magnetic amplifier control. It's the easiest drive to set up and operate. A twist of the dial gives you stepless speed adjustment from zero to full speed in either direction. Each adjustment is independent, thus sparing you the need for compensating adjustments of inter-related settings. You get more consistent day to day operation because transistors — *unlike tubes* — are highly dependable.

The new Select-A-Spede defies obsolescence. To add functions you simply have your electrician install any of 13 "building-block" control circuits as your conditions require. These circuits come on inexpensive 6" x 6" panels ready for installation and are immediately available from Louis Allis stock. Thus a rebuilding or adaptation job that, on former equipment, cost thousands of dollars — excluding downtime — can now be done at a fraction of the cost and time *right in your own plant!* High quality transistors, field proven in missiles and other advanced electronic equipment, assure you of a high degree of dependability with a life expectancy of 15 or more years. Printed low-voltage transistor circuits are virtually trouble-free and can be quickly and easily replaced from low-cost stock.

Further savings are provided by the new Louis Allis Flexitorq® drive motors through vastly improved commutation, low brush wear, and their ability to safely withstand momentary overloads of 400% of normal horsepower rating.

Select-A-Spede sizes from 5 to 400 hp, speed ranges up to 20:1. Contact any one of the 60 Louis Allis District Offices for information and application assistance. Or write for bulletin 2001 to The Louis Allis Co., 449 E. Stewart Street, Milwaukee 1, Wisconsin.

LOUIS ALLIS

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

SA-202

Get the True Facts of Life!

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ASK YOUR DEALER ABOUT EATON 2-SPEED AXLES

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in Trucks Today

Your truck dealer will tell you how Eaton 2-Speed Axles can extend the life of your trucks by thousands of trouble-free, low-cost miles.

By reducing engine rpm in relation to vehicle speeds, Eaton 2-Speed Axles hold down wear on engines and all power transmitting units. They add to miles travelled and number of loads carried between engine overhauls; they reduce maintenance costs; keep trucks on the road, out of the shop. Your dealer will also tell you that trucks equipped with Eaton 2-Speed Axles bring higher allowances when traded in.

Get the facts—then specify Eaton 2-Speed Axles on the next trucks you buy; they will pay for themselves many times over.

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EATON AXLE DIVISION
MANUFACTURING COMPANY
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Motors and Generators....that's our Business!

can do!

During your next planning pow-wow on a forthcoming project, consider this challenge (ME* Can Do!) from a tribe of "Injun-eers" who make motors and generators their only business . . . and who have been successfully conducting this business on product merit for nearly 50 years.

Feathers in our bonnet include some of the world's most honored projects and our scalp belt includes a multitude of the leading names in industry, but the Chiefs at ME* are more interested now in what ME* can do . . . for you!

Wherever you are, whatever your requirements, there's an ME* Sales Engineer ready to visit your reservation, sit in at your council fire and discuss your requirements . . . help you with your planning . . . prove the superiority of Marathon Electric Motors and Generators.

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MANUFACTURING CORPORATION

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Offices in Principal Cities

Building a "perfect 36" from Joliet to Chicago

60-mile line of The Peoples Gas Light and Coke Company and Chicago District Pipeline Company spans congested area —under rivers, streets and railroads with minimum disturbance and maximum protection to populace

It was business as usual during construction of the third Calumet Line — a 36-inch pipe that will ultimately deliver 557 million cubic feet of natural gas per day to the Chicago area. Although the line crossed 77 roadways, 25 railroads and six principal streams, careful planning kept road, rail, barge and ship traffic flowing smoothly.

A. O. Smith supplied 20,000 tons of the largest standardized steel pipe available. The choice was natural. For over 30 years . . . A. O. Smith line pipe has always been manufactured to a high standard of quality . . . precisely controlled at every step of production. That's why A. O. Smith pipe is found in so many important pipeline projects.

Through research . . . a better way

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New York 17 • Tulsa 3 • A. O. Smith INTERNATIONAL S.A., Milwaukee 1, Wis., U.S.A.

ROADS — Pipe tunneled under 77 roadways. Special steel plates were used to cover trench to keep streets, driveways and parkways open. In residential areas, special rubber-tired equipment kept down noise . . . mechanical sweepers kept down dust.

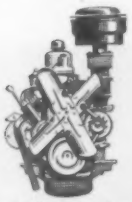
RAILWAYS — Line crossed 73 tracks of 17 railroad companies. Here workmen are installing steel casing for the line under the Atchison, Topeka & Santa Fe and The Gulf Mobile & Ohio tracks south of Joliet.

STREAMS — Line dives under the Calumet River on Chicago's south side. Tunnel is 687 feet long. Top of the tunnel is 60 feet below the surface. One of six river crossings constructed on the third Calumet Line.

CHEVROLET

"GET IN A PLOWED FIELD WITH 7 TONS OF LIME, YOU SEPARATE THE MEN FROM THE BOYS IN A HURRY."

Out around Eastman, Georgia, you'll see that medium-duty Chevy hard at it 6 days a week, covering about 200 miles a day for Mr. C. D. Coursey, owner of a lime and fertilizer spreader service. Over plowed fields, fighting mud and furrows, its Jobmaster 6 engine pours it on all day and still gets an exceptionally good 10 miles to the gallon. Mr. Coursey's sold on Chevy's lugging power. "It has plenty," he'll tell you. "I can get more work done in a day because I can travel faster in the field *and* on the highway." He likes Chevy's cab comfort and ride and handling and road-holding ability. He likes Chevy, period.



■ On a farm or out in the oil fields—get a 6-cylinder engine that can handle big-tonnage loads and you've got your overhead down where it's no bother at all.

That's the reason you see the big 261-cu.-in. Jobmaster 6 in so many hard-working middleweight Chevrolets. This engine's been building up a reputation over the years as the workhorse of the industry. Its valve-in-head design is dedicated to dependability. Built to turn out an efficient 150 horsepower (with a high 8.0 to 1 compression ratio) and get the most out of every gallon of gas while serving up plenty of load-pulling power.

That 1960 Thriftmaster 6 pickup you see in the second picture is used as a service vehicle on Mr. Coursey's 700-acre farm—and averages 18 miles to the gallon.

The thing to do is drop in on your dealer and check the Jobmaster specs in detail. At the same time you can get the dope on Chevy's *new* work-saving Powermatic transmission. It's now available in Series 60 through 80 models. Talk engines, models, capacities, everything. Just be sure to save some time for a trial run in a '60 Chevy. Honest to gosh, you've never in your life driven a truck like this one. You'll see why drivers are praising it to the sky. You'll see why cargo damage is a pain of the past. You'll see why so many Chevy truck operators are able to get more work done in a day. And why the trucks are able to go thousands of more miles before trade-in time. Make it soon. . . . Chevrolet Division of General Motors, Detroit 2, Michigan.

1960 CHEVROLET STURDI-BILT TRUCKS

CHEVROLET

SEAMLESS

- Long radius or short—the finest ells ever made . . . hot coined for dimensional accuracy from end to end
- Forged at controlled heat for superior metallurgical quality
- Specially machined ends for quickest fit-up and welding
- Ells, tees, returns—all types of fittings—available in seamless through 24"
- Produced by newest, most modern equipment, combined with latest technology in forging, sizing, heat-treating and machining

Now... Midwest makes BOTH!

WELDED

- Formed from plate and welded—fully reinforced . . . same high quality as always
- Especially suited for Long Tangent bonus elbows, reducing ells, and special fittings of unusual shapes
- Stocked in carbon steel, wrot iron, chrome-moly . . . available in Hi-Yield and all other weldable metals
- Wall thicknesses up to 4"—or more
- Delivery from stock—with or without Long Tangents—in all sizes through 36"; to order, through 48"

The world's most complete line of welding fittings...for maximum flexibility in piping design

SOLD THROUGH STOCKING DISTRIBUTORS FROM COAST TO COAST

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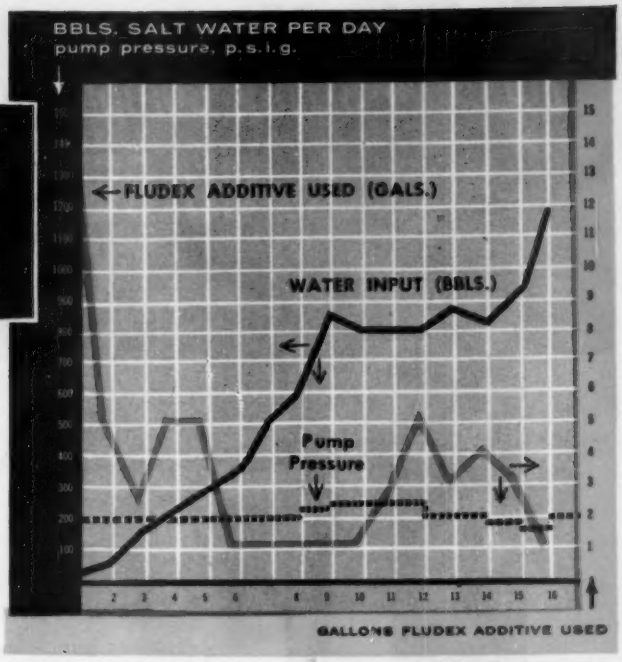
report



One drum of FLUDEX* *Water Flood Additive restores "problem" well to useful service*

INCREASES SALT WATER DISPOSAL CAPACITY FROM 15 TO 1200 BBLS. PER 8 HR. DAY

An East Texas salt water disposal well had a 10-year history of difficulties. It had been acidized 8 times during this period and treated with 100% chlorine twice a week for 6 years. It had a well depth of 3700 feet, 7-inch casing, 5½-inch tubing, bottom of hole open.

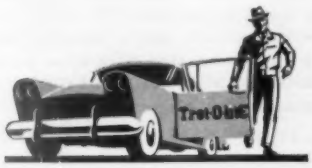
When treatment with FLUDEX Water Flood Additive was started, the daily 8-hour input capacity was 15 barrels at 200 p.s.i.g.

How FLUDEX *Water Flood Additive was applied*

Ten gallons of FLUDEX additive were dumped into the well, then input pump started. At the end of 7 hours, the well was taking 2 gallons of water per minute. Five gallons of FLUDEX additive were flushed down the well bore and pumping was discontinued for the night. Total disposal well input for this day was 15 barrels of water.

The following day FLUDEX treatment was resumed, and continued for 15 days. (See chart.) At the end of the 15-day period, input capacity had increased to 1200 barrels (injection pressure remaining at 200 p.s.i.g.) per 8-hour pumping period. In addition, with the pump off, the well would take about 30 barrels per hour by gravity flow alone.

For complete information on how FLUDEX Water Flood Additive can help *your* operations, ask the Man in the Red Car. Or write to . . .



*Registered trademark of Petrolite Corporation

TWF 60-3

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For Dual String Completions – Flowing or Pumping

Use GUIBERSON'S RETRIEVABLE TYPE RD PACKER

Type RD Packer with Anchor and Plain Stinger

This cleanly designed, rugged packer is an outstanding Guiberson development for dual string installations in wells of any depth.

Outstanding in performance because it operates perfectly with both zones flowing, high or low differential pressure; with either zone flowing, the other zone pumping; with both zones pumping; with either or both zones on gas lift; or for multi-zone injection — gas or water.

Outstanding in advantages because it completely isolates each zone from the other and from the casing; provides full opening long string to lower zone; permits either string to be pulled or run separately.

Guiberson's RD packer does complex dual zone jobs so well that operators tell us it's their best investment for dual string production. Ask your Guiberson representative about installation and auxiliary equipment recommendations.

Guiberson's RD packer has smooth operating dovetail slips of heat-treated alloy steel. Packing rubber is one-piece sleeve type — will not vulcanize in the well, made of Guiberson's special oil and gas resistant compound. You can get the RD packer with or without anchor, and a choice of stingers, plain or with snap-ring. Piston slips have extra large gripping area, are heat-treated alloy steel and keyed to anchor body up to maintain proper alignment. Get the Best — Get Guiberson.

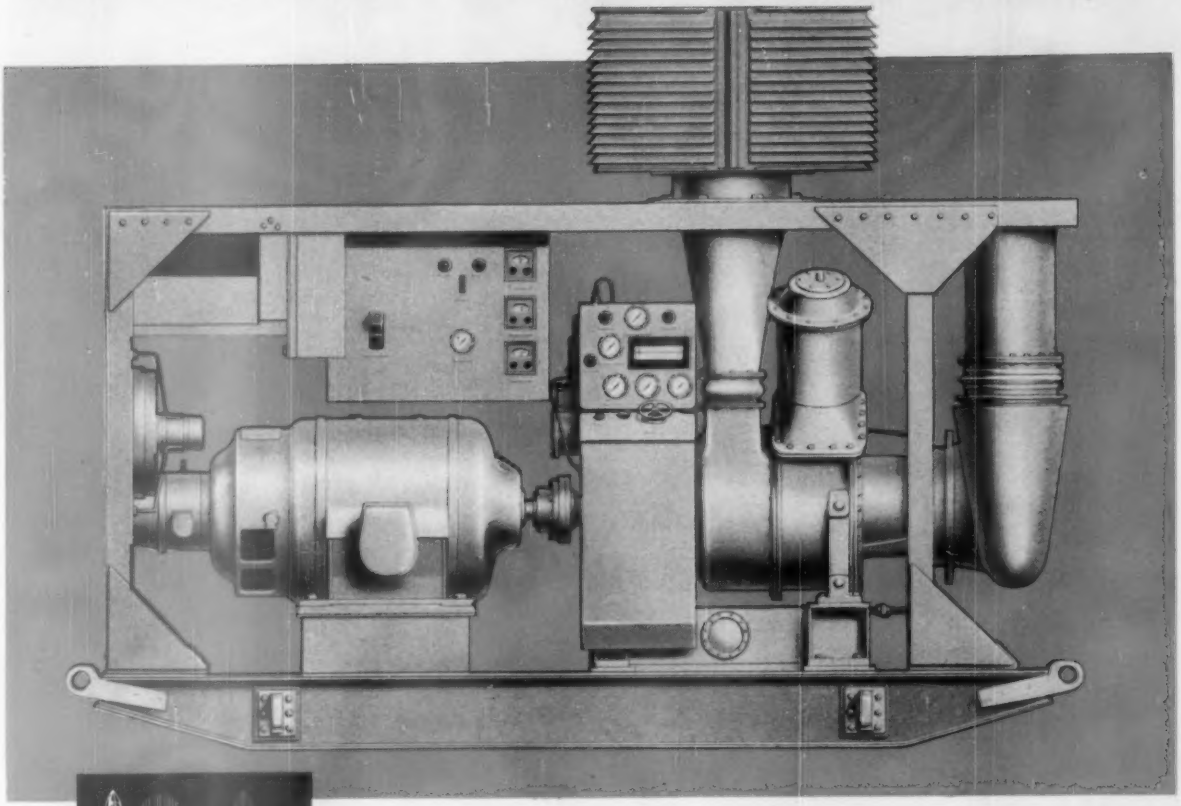
GUIBERSON

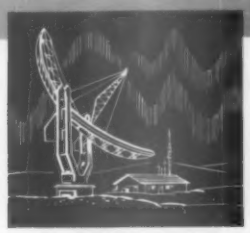
THE GUIBERSON CORPORATION

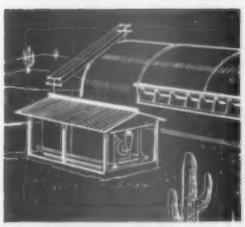
ESTABLISHED 1919
DALLAS, TEXAS
U. S. A.

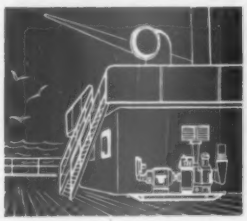
Sold by
Oil Field Supply Stores
Everywhere

NEW Thompson-Ruston Model "TE" 300 kw Gas Turbine Generator Set









This gas turbine generator set is different. It is specifically designed for industrial portable or standby power requirements. This is not a delicate gas turbine—its experience has been on the ground, breathing the air and eating the dust of industrial atmospheres.

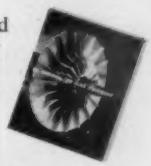
Compared to ultra-lightweight gas turbine generator sets of the aircraft type, the Model "TE" offers these important advantages:

PROVEN RELIABILITY—Simple, single-shaft, open-cycle design. The only turbine in its horsepower range designed and built for 50,000 hours service life.

EASY MAINTENANCE—Built to deliver a minimum of 5,000 hours between inspections, with all components easily accessible for routine maintenance.

RUGGED CONSTRUCTION—Engineered with low component stresses for heavy-duty service.

Complete specifications and performance data on this rugged new generator set are yours for the asking. Write on your company letterhead for additional descriptive data on the Thompson-Ruston Model "TE" Generator Set.



TRW

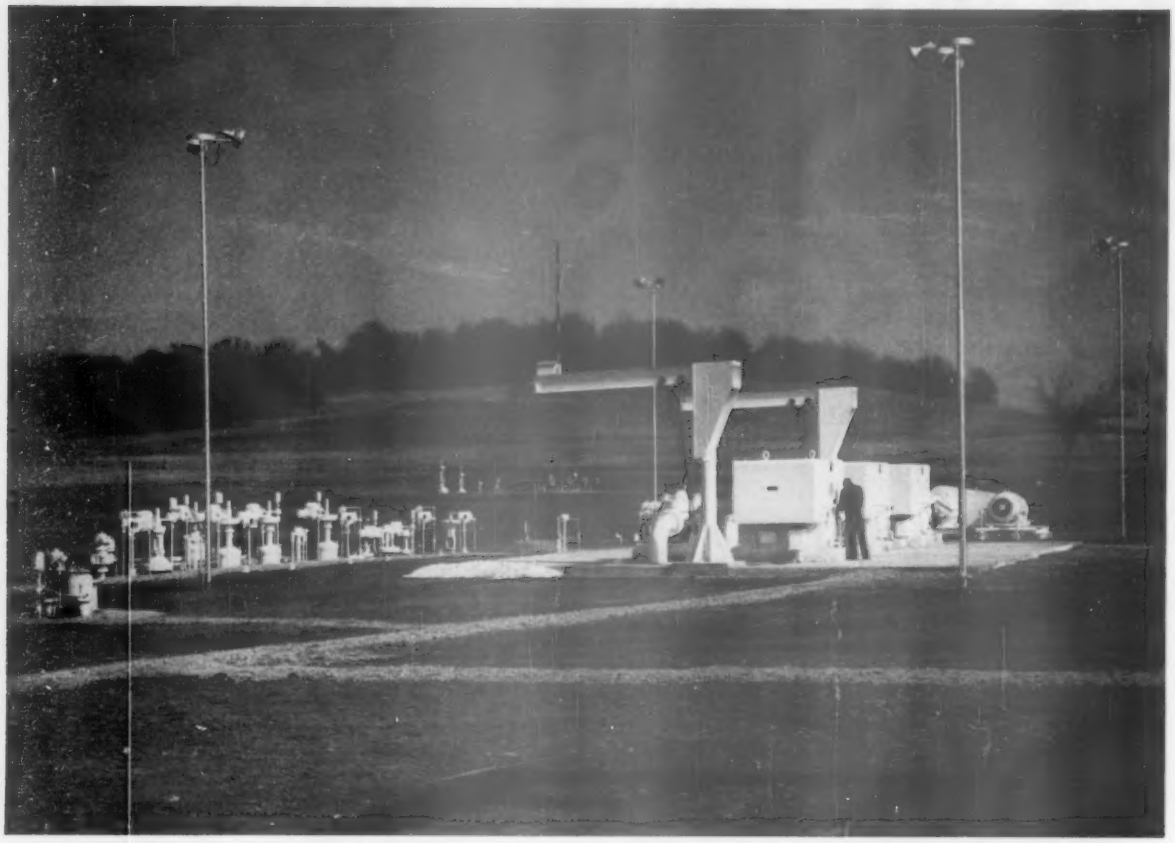
TAPCO GROUP

Thompson Ramo Wooldridge Inc.

OG-560 , Cleveland 17, Ohio

You can depend on purchased electric power for

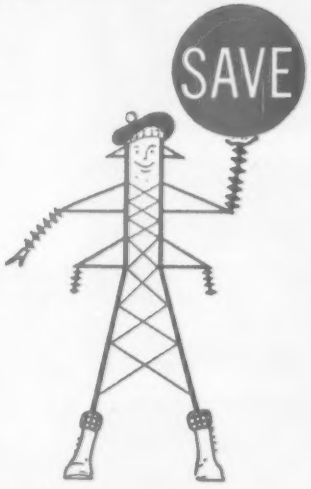
REMOTE CONTROL



Remote-controlled crude station with three 1250 hp and one 200 hp electric motors

This remote-controlled crude station is typical of the modern trend in electrification. In addition to the four electric motors, the valves and sump pump are all controlled from a town some distance away. This installation is dependably served with utility electric power and a fine example of adaptability of purchased power to remote control.

For pipelines, as well as for producing fields and refineries, you can always depend on utility electric power. See your nearest utility electric power company for assistance or write the Petroleum Electric Power Association.

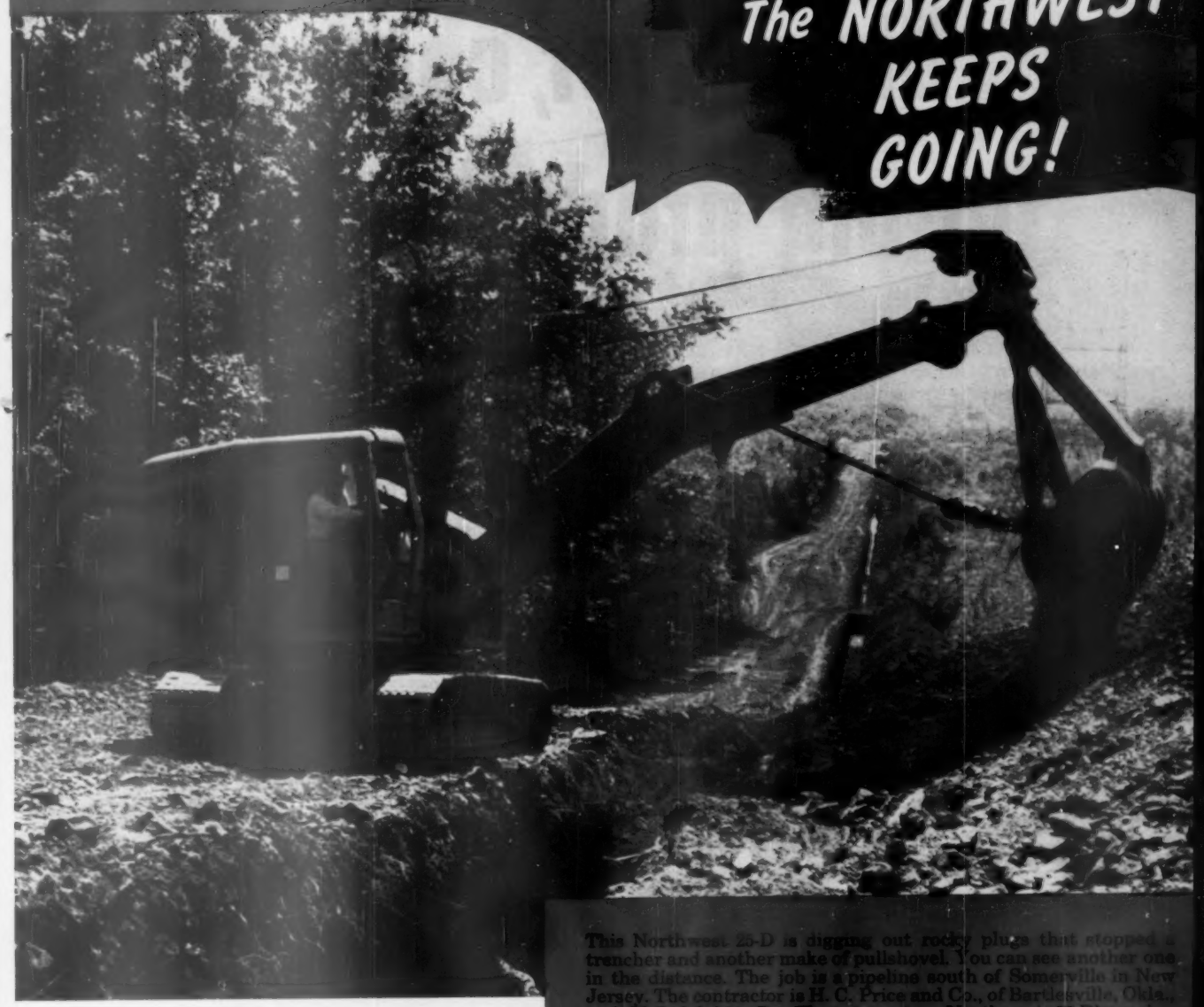


Purchased Electric Power . . . saves money, manpower, maintenance, and serves you better automatically

Petroleum Electric Power Association P. O. BOX 35006. DALLAS 35, TEXAS

When everything else is stopped . . .

The NORTHWEST KEEPS GOING!



P-25-18-LC

This Northwest 25-D is digging out rocky plugs that stopped a trencher and another make of pullshovel. You can see another one in the distance. The job is a pipeline south of Somerville in New Jersey. The contractor is H. C. Price and Co., of Bartlesville, Okla., and Philadelphia, Pa. There are two Northwest 25-D's and a Northwest 25 on the job. The two 25-D's are the fifth and sixth Northwests that this well-known contractor has bought.

Contractors everywhere are finding the 25-D outstanding as a ¾-yd. machine. Its smoothness of operation and its ease of maintenance puts it far ahead of rigs of equal capacity. Drum brakes and clutches are larger. Larger Uniform Pressure Swing Clutches give even greater smoothness and positive control in spotting loads. Larger Drums give greater cable capacity. Longer, wider crawlers assure greater stability. Grouped Lubrication brings time saving in upkeep. For crane work you have the 25-D, 18-ton Lifting Crane with the Northwest High Speed Worm Gear Boom Hoist, true Power Load Lowering, and many other crane advantages.

H. C. Price & Co. operator Michael Arsenich says — "Have operated 21 years. I like Le operating Drums and Swing Clutches. They mean smoother performance. When everything else is stopped the Northwest keeps going." Operator Harry E. Roberts says, "Have operated for 20 years. They'll dig in hard digging where nothing else will do it. They're the best."

If you are considering the purchase of a new crane, shovel, or dragline, whether on crawlers or rubber, get the full story on Northwest's newer developments.

NORTHWEST ENGINEERING COMPANY
1513 Field Bldg., 135 South LaSalle St., Chicago 3, Illinois

CRANES
SHOVELS
DRAGLINES
PULLSHOVELS
TRUCK CRANES

3/4 to 3 Cu. Yd. Capacity

NORTHWEST

New TD-15 oil field special...

Big power, compactly for big production, easy

"Measure up" the International TD-15 Oil Field Special against all the others and you'll prove it's the big producer of the 100-hp class!

Top push-power

At your fingertip command the TD-15 gives you 20,500 lbs. of stump-grubbing, caliche-digging, rock-bossing push. The "15's" high-torque International diesel engine develops 105 hp at only 1,650 rpm—is 6-cylinder smooth!

6 speeds, coming and going

You match dozing and repositioning speeds exactly to working conditions with the TD-15's 6-speed, full-reverse transmission. Change gears and change forward-reverse directions with one fast hand-sweep of the "single stick" shift, and the Shuttle-Bar control lever.

Sintered-metal clutch efficiency

Engage and disengage the "15's" *dry type* heat-defying sintered-metal-faced engine clutch hundreds of times daily—and keep on getting the same high power-transfer efficiency, every time. And simplified clutch design also simplifies maintenance!

Dura-Roller Dependability

Exclusive International Dura-Rollers smoothly carry the "15's" work-slugging weight! These dual-protected heavy-duty 1,000-hr. lube interval track rollers are designed to roll up new economy records in "eat-'em-alive" oilfield conditions.

packaged transport!

Another TD-15 of Contractor Rumbaugh's fleet gouges out hard-packed caliche from ancient beds—stockpiles it for road surfacing on Gulf Corporation leases near Goldsmith, Texas!

Pit-Fitting Blading

New International outside push-arm hydraulic bulldozer concentrates TD-15 power along the 8-foot-wide cutting edge! Blade is sized to speed slush pit digging. New earthrolling blade contour, diagonal reinforcing struts and columbium-treated push arms match 'dozer strength to TD-15 power.

5-minute "move-outs!"

You get 62-inch gauge stability and maneuverability in the TD-15 Oil Field Special. Yet, maximum width (blade equipped) of only 8', and total operating weight of 26,000 live-action lbs. allow 5-minute "move-outs" by truck, day or night—without a highway permit!

'Dozing blow-sand from a Texas drill site in "grinding compound" conditions—Rumbaugh Construction Co., Odessa, "thank their stars" they've got crawlers equipped with Dura-Rollers! (This oilfield contractor owns three TD-15's!) Says V. L. Wilson, Rumbaugh's superintendent: "Powerful, compact, fast-working, clean—the TD-15 has big tractor working abilities!"

Contractor Art Muller, Frannie, Wyoming, handles lots of small jobs—finds the TD-15's extra power and speed ideal to finish fast, and hurry on to the next contract. Under many conditions, the fast-working, easy-to-haul TD-15 takes care of the big jobs for them as profitably as their bigger equipment!

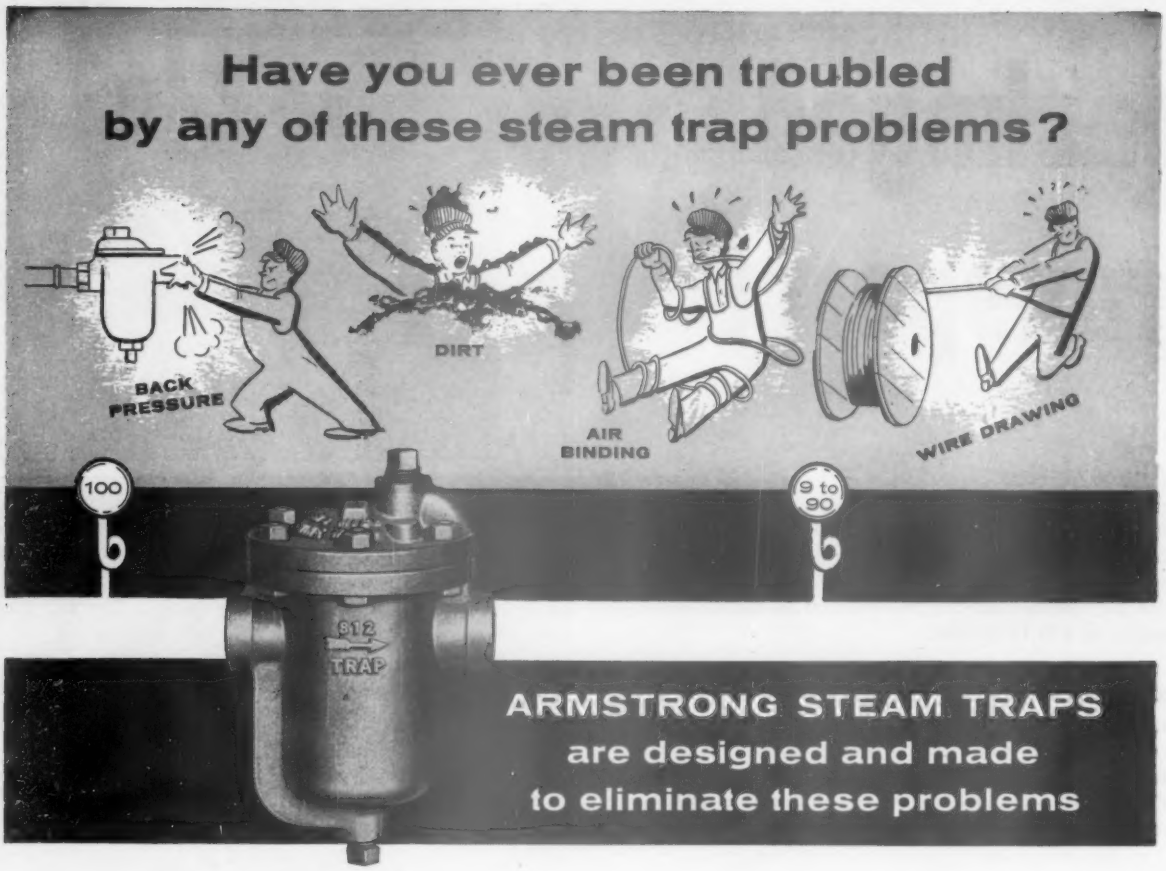
International Dura-Rollers feature the industry's thickest shells; king-sized lube reservoirs; and positive grit-exclusion with full-floating, precision-lapped seals! Exclusive pressure relief passages let you power lubricate Dura-Rollers, without affecting seal life or efficiency!

Prove the TD-15 Oil Field Special's industry-topping performance and ease of transport to yourself. Let your International Construction Equipment Distributor demonstrate!

International® Construction Equipment

International Harvester Co.,
180 North Michigan Ave., Chicago 1, Illinois
A COMPLETE POWER PACKAGE

Have you ever been troubled by any of these steam trap problems?



ARMSTRONG STEAM TRAPS are designed and made to eliminate these problems

BACK PRESSURE . . . Armstrong Traps operate on any back pressure—or vacuum, for that matter. As long as there is a pressure differential across the trap, it will close on steam and open for condensate. Even the high back pressure caused by blow through of one or more traps in the system will not disturb Armstrong Traps. Other than a reduction in capacity, Armstrong Traps are unaffected by back pressure.

DIRT . . . Armstrong Traps are not affected by ordinary dirt. When the trap opens condensate swirls down under the edge of the bucket and up through the discharge orifice. Dirt is kept in suspension and discharged along with the condensate. For very bad dirt conditions, Armstrong offers traps with integral strainers. These cost less than a trap plus a separate strainer.

AIR BINDING . . . Armstrong Traps cannot air bind. Air in the system passes through a vent in the top of the bucket. It collects in the top of the trap and is discharged with the condensate. There is no chance for it to stop the trap. For low pressure on-and-off units where large amounts of air accumulate while the steam is off, Armstrong offers open float and thermostatic air vent traps in a complete range of sizes.

WIRE DRAWING . . . Armstrong Traps are designed and made to resist wire drawing. The valve and seat are tough stainless steel. The valve opens and closes tightly with a fast action and is always water sealed. There is virtually no chance for grit or sediment to lodge in the valve, virtually no chance to create conditions that lead to wire drawing.

There's no need to accept any of these problems as "inevitable." Your local Armstrong Representative can show you how to end them all. Call him today or write direct.

860 Series for low pressure heating service.

800 Series, side inlet, side outlet.

No. 803, side inlet, bottom outlet.

880 Series, integral strainer.

200 Series, bottom inlet, top outlet.

Forged Steel Series for high pressures, high temperatures.

The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

ARMSTRONG MACHINE WORKS
8683 Maple Street Three Rivers, Michigan

... find oil fast
at lower cost!

oedip *Map drawn and edited by the Institut Géographique National.*

Parentis - Lacq
Hassi-Messaoud - Zarzaïtine
Tiguentourine - Hassi R'Mel

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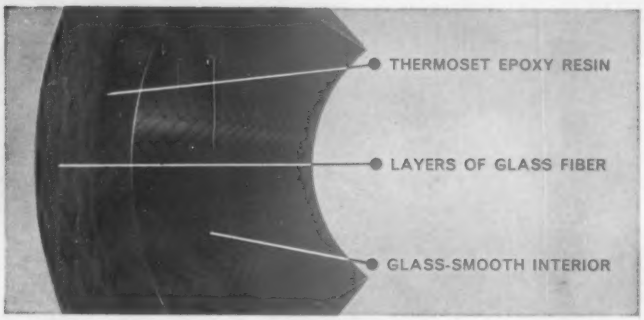
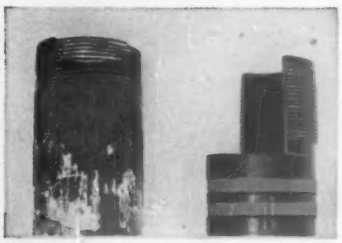


EPOXY RESIN AND GLASS FIBERS combined in a high-speed centrifugal casting operation. High quality components processed under rigid quality controls bring to industry a unique and efficient non-metallic pipe.

"Impossible" corrosion, temperature and pressure problems solved by Fibercast® epoxy pipe

- Operating temperature range wider than any non-metallic pipe (–65° to 300° F.)
- Operating pressure range extends to 1000 psi.
- Effectively combats corrosion, contamination, abrasion, scaling, electrolytic action.



Fibercast Tubing (right) used to suspend a 1,200 lb. pump for 3 years in a salt water supply well. *There was no loss in strength.* The damaged plastic-coated steel nipple (left) was used in the same installation, failed after 3 months' service.

WHAT is Fibercast?

It is a centrifugally cast, thermoset, epoxy resin reinforced pipe that handles temperature and pressure problems where no other non-metallic pipe will do.

Its body of woven glass fibers provides resistance to high tension forces. These fibers, combined by adhesion, are imbedded and bonded by heat in epoxy resin. The result is a strong, long-lasting pipe with remarkable ability to withstand high pressure and temperature in corrosive environments.

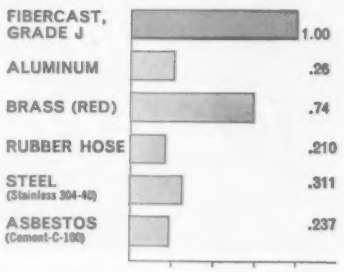
WHY use Fibercast?

For a multitude of reasons. Because its advantages range from superior resistance to heat, pressure and corrosion, to its ease of handling, light weight, dielectric properties and structural stability. Because Fibercast's long service life alone would justify choosing it over other materials. Because even more expensive metal pipe or pipe with thermo-plastic interior coatings cannot match Fibercast's proven durability. Case histories and accurate testing have proved over and over that Fibercast performs better, lasts longer, costs less. Out of 338 common corrosive solutions, Fibercast competently handles 320. And naturally, Fibercast's unique and lasting qualities under such conditions mean that it drastically reduces maintenance and replacement costs, too.

Although Fibercast's light weight makes it correspondingly easy to work with (it is less than 25% the weight of steel), it has the same basic linear coefficient of expansion as steel (7.06 x 10^{-6} to 8.25 x 10^{-6} in./in./°F.). Fibercast's strength permits installation on pipe racks with span lengths generally used for metal pipe.

The pipe has a smooth interior, with a Hazen-Williams C Flow Factor of 147. This cuts friction losses, aids flow and tends to resist build-up. It is a non-conductor (accepted by the electrical industry as a superior insulator), and is not subject to cold flow. A low coefficient of heat transfer (3.0 x 10-3 Cal/CM^2/sec/CM°C.),

COMPARATIVE LIFE DATA*



*Basing Fibercast as unit life of 1 and others as comparative percentages thereof.

minimizes heat loss and may even eliminate heat tracing.

All three major systems of joining all pipe are used with equal success on Fibercast. They are: standard flanged, cemented, and threaded and coupled with a complete selection of Fibercast fittings (the world's largest line of corrosion-resistant epoxy pipe fittings).

Safety, too, is an important reason for using Fibercast Pipe in transporting dangerous chemicals, particularly in areas where the pipe is adjacent to personnel. Most piping materials corrode undetectably from inside-to-out and can suddenly burst without warning, inflicting injury to personnel. Because of Fibercast's woven glass fiber construction, such occurrences, if they ever occur, *are* detectable in minute, repairable leaks.

WHO uses Fibercast?

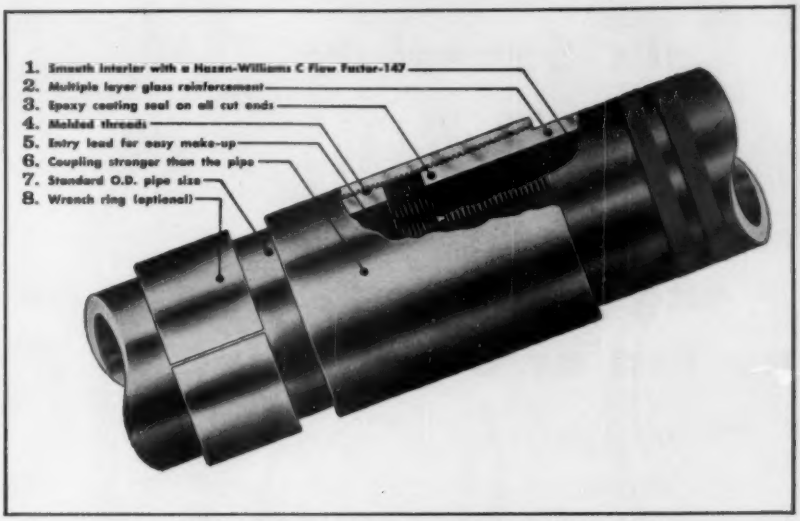
The petroleum industry . . . chemical . . . petro-chemical . . . nuclear energy . . . textile . . . paper . . . and food-processing industries . . . countless operations handling acids, alkalies, salt water and other corrosive liquids under pressure can all use Fibercast profitably.

In oil country, Fibercast is already

Workman is painting a section of Fibercast Pipe bearing 32% HCl at Shell's Texas Chemical plant. Note that Fibercast has sufficient strength for installation on span racks with the spacing normally used for metal pipes.

widely acclaimed for superior performance in rugged, abusive and even high pressure installations like salt water disposal wells and horizontal lines. In cases where other pipe and tubing required replacement after just a few weeks of service, Fibercast is still performing efficiently after many years.

In petro-chemical and chemical-processing plants, Fibercast is valued not only for high heat and corrosion resistance, but also for its remarkable maintenance of the purity of the solutions it is required to carry. Such installations range from Fibercast pipes which carry 37% hydrochloric acid at ambient temperatures to lines carrying solutions containing brine, alum, and other sulphates, sulphuric and phosphoric acids, and other damaging chemicals.


1. Smooth interior with a Hazen-Williams C Flow Factor-147
2. Multiple layer glass reinforcement
3. Epoxy coating seal on all cut ends
4. Molded threads
5. Entry lead for easy make-up
6. Coupling stronger than the pipe
7. Standard O.D. pipe size
8. Wrench ring (optional)

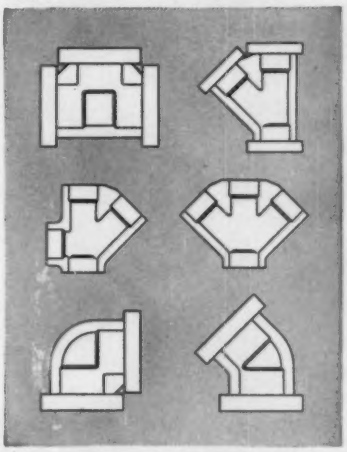
8 Points of Fibercast Superiority

Food-processing industries, among the most demanding of all industries in purity, corrosion and heat standards of operation, know the long-term benefits of using Fibercast. Fibercast is especially effective in the processing of foods requiring use of sulphuric and phosphoric acids (such as corn syrup, starches, gelatins), as well as brines and other highly corrosive acids and solutions.

The operating conditions peculiar to the man-made textile and paper processing plants are also improved by the use of Fibercast Pipe and Fittings. The ever-growing demands of all industry . . . the rigid quality controls imposed by governmental and other agencies . . . the unique and often unsolved needs of new processes and methods . . . all of these factors help to create "impossible" problems that can be solved by the use of Fibercast.

Complete Line of Fittings

Fibercast provides fittings to solve any fitting problem. Besides a vast stock of standard sizes and types, Fibercast also designs and makes special fittings to meet individual requirements. All, of course, have the same corrosion, pressure and heat resistance properties of Fibercast Pipe and Tubing. A few of the regularly stocked types are shown in the line drawings below



If *you* have an "impossible" corrosion, temperature, or pressure problem, consider the advantages of using Fibercast. To receive a free sample of Fibercast, and to get specific information about how Fibercast can help *you*, mail the coupon below.

FIBERCAST COMPANY
BOX 727, Sand Springs, Oklahoma

Please send me further information about Fibercast Tube and Pipe. OG-5A

Name_____

Title_____

Firm_____

Type of Business_____

Address_____

City_____ State_____

FIBERCAST® COMPANY

A DIVISION OF **Youngstown** SHEET AND TUBE COMPANY

six Superiors 357,000 engine hours... no major overhauls!

"We're sold" says Worley and Harrell Drilling Contractors

Six Superior 6G-510 gas engines are performing with profit-boosting dependability in cold-weather country for Worley & Harrell Inc. of Tulsa. Powering two 80B rigs that have drilled 1,118,078 ft. of hole in the Williston Basin, the 6-cylinder Superiors are still going strong after 357,000 engine hours without overhaul. No major parts replacements have ever been required, such as cylinder liners, pistons, bearings, crankshaft, cylinder block, etc.! Engines of other makes often are completely replaced during this length of service. All engine service needed, in over eight years of continuous operation, took place right on the rigs!

"Best drilling engines we've ever seen," declares Burrel Harrell, Vice President and Drilling Superintendent. President Loyd Worley agrees. They practice good maintenance, hire top crew men, but mainly credit Superior's high quality construction for insuring trouble-free power on long-run jobs. Contributing to minimum maintenance and repair costs are Superior's simplicity, rugged design and elimination of high mortality parts.

Worley & Harrell's experience proves that if your power requirements are in the 190 to 2150 BHP range, it pays to specify White Superior engines! Get complete information today from leading rig manufacturers, White oil field representatives or through White Diesel Engine Division.

Superior ENGINES ATLAS Imperial DIESEL ENGINES White DIESEL

White Diesel

WHITE DIESEL ENGINE DIVISION
THE WHITE MOTOR COMPANY

Plant and General Offices: Springfield, Ohio

Every joint you put in the ground . . . puts twenty-three dollars in your pocket

Tex-Tube Lightwall Pipe saves you money in pipeline construction. Because it is made from high-strength steel, its lighter wall does the work of a standard wall. In a 1000-lb. gas line, for example, Tex-Tube 6⅝″ x .156″ wall TX-52 costs you $56 per joint as compared to $79 per joint of standard weight .280″ wall. This is a savings of $23 per 45-ft. joint, or $2680 per mile.

So much for initial savings. In addition, Tex-Tube Lightwall is easier handling, faster laying. The larger inside diameter is still another bonus.

For the full story, call the man from Tex-Tube in your area, or write us.

PIPE MANUFACTURERS
High Tensile Lightwall Pipe
Oil Well Casing
Oil Well Tubing
Structural and Mechanical Tubing
Shot Hole Casing
Upsetting, Threading, Normalizing

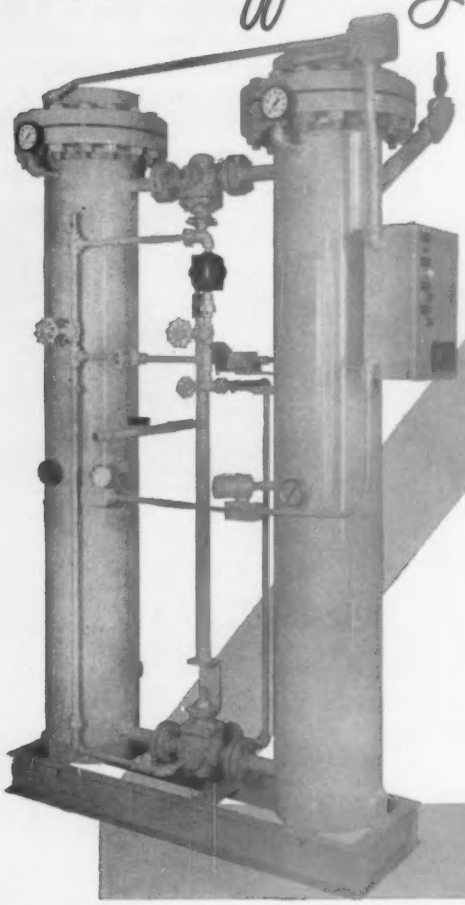
DISTRIBUTORS
Oil Country Goods
Line Pipe
Refinery and Chemical Plant Piping

TEX-TUBE, INC.

1503 NORTH POST OAK ROAD • HOUSTON, TEXAS
Sales Offices in Midland, Amarillo, Dallas, Tulsa and Los Angeles

KEMP ORIAD DESICCANT DRYERS

cut costs, add efficiency 4 ways!



1 Complete reactivation

An exclusive 3-zone embedded heater design gives every Kemp Oriad Desiccant Dryer extra drying power *economically* (effective distribution of heating elements assures high heat transfer efficiency). The most complete reactivation results...providing maximum desiccant capacity, minimum dewpoint performance.

2 Full automatic operation

Set the program timer and everything is regulated automatically. Gases are dried with the least pressure loss, lowest maintenance and operating costs. Your choice of manual or semi-automatic systems, too.

3 Accurate temperature control

Thermostatic control conserves heat input... maintains ideal temperatures for highest operating efficiency in drying instrument air, process air and gases to the lowest dew point, eliminating condensation or freeze-up, and other applications.

4 No moving parts

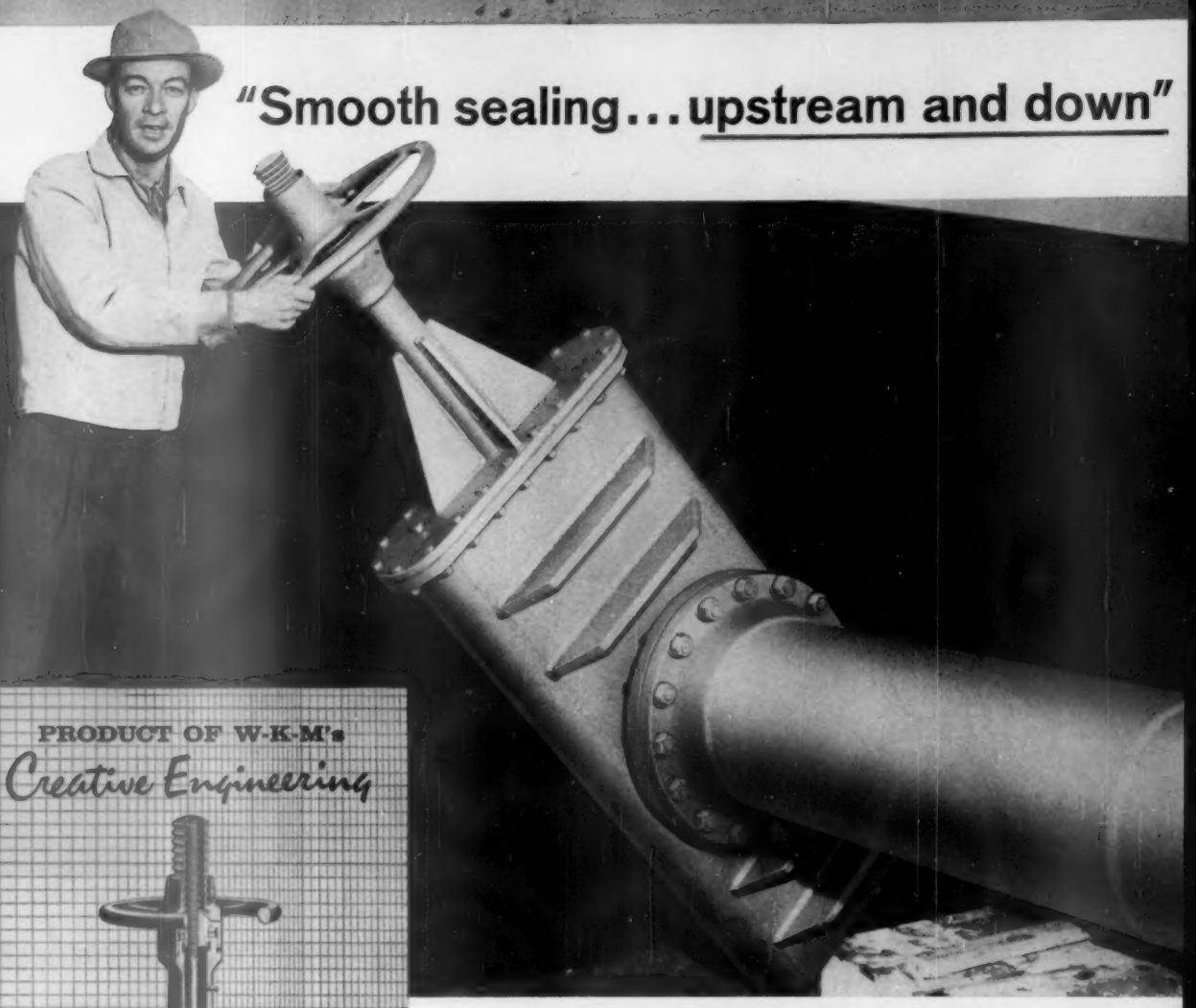
There are no blowers, fans or motors to create maintenance problems, rising operating costs. Unit comes fully assembled, ready to install and operate. Write today for Bulletin D-103, or contact your Kemp man, listed in the *Chemical Engineering Catalog*.

It always pays to come to

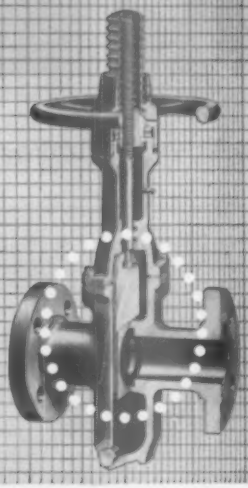
KEMP OF BALTIMORE

THE C. M. KEMP MANUFACTURING COMPANY
405 E. Oliver St., Baltimore 2, Md.

"Smooth sealing... upstream and down"



PRODUCT OF W-K-M's
Creative Engineering



FLOATING SEATS MAKE THE SEAL

Seats are specially formulated rubber molded to a hardened steel insert. They float against the gate. When the gate closes, line pressure forces the gate against the downstream seat making a tight seal. The upstream seat maintains its seal against the gate for an upstream seal. The valve provides a tight seal under little or even no line pressure or under vacuum conditions.

W-K-M's new Pressure Sealing Gate Valve

Almost without effort . . . you get a tight seal on *both* sides of the line. The secret? A unique seat design that puts line pressure to work *for* you. The greater the pressure, the tighter the seal!

Seats automatically adjust for wear . . . automatically relieve excessive body pressure. And on-the-line overhaul is easy.

Specify W-K-M's economical new Pressure Sealing Gate Valve for pressures to 720 psi (cwp) and temperatures to 250° F. Sizes 2" through 30". *At leading supply stores everywhere.*

WRITE FOR CATALOG 1200

W-K-M

DIVISION OF ACF INDUSTRIES
INCORPORATED
P. O. BOX 2117, HOUSTON, TEXAS

5925

Solids by pipe...

Can you meet the challenge of this new day in bulk transportation?

Will you be in the running when the pipeline industry's biggest new job starts taking shape?

Solids by pipeline is no longer a dream. It's a highly successful reality.

Gilsonite . . . coal . . . *what raw material will be next* to start moving to market through a pipe?

As you get set to meet the mighty challenge and opportunity that solids pipelining presents to your industry, remember this:

1. Men who engineer solids pipeline systems find that *uniform concentration* of solids is a must in a pipelined slurry.
2. You can get the slurry uniformity you want—with LIGHTNIN Mixers.

LIGHTNIN Side Entering Mixers keep 700 tons of solids per day uniformly suspended for dispatch through the pioneer American Gilsonite Co. pipeline. LIGHTNINs in thousands of chemical plants mix slurries of every kind, rapidly, dependably—*to the exact level of uniformity needed.* If it can be slurried, you can slurry it *uniformly* with LIGHTNINs.

If you'd like quick, competent help on slurry suspension for a specific project, call in your LIGHTNIN Mixer representative now. He's listed in Pipeline Composite Catalog. Or write us in confidence.

Good mixing helps move Gilsonite over a mountain

Solids pipeline built by American Gilsonite Co. makes the refining of gasoline from Gilsonite economically possible. It saves more than $4 per ton—a million dollars a year—over other methods of transporting Gilsonite ore over a mountain from mine to refinery.

American Gilsonite's 6-inch pipeline carries slurries averaging 38% solids and 62% water at 350 gallons per minute. It delivers more than 700 tons of solids per day at the downstream end, 80 miles from the eastern Utah mine.

Cut from the solid vein with high-pressure jets of water, the shattered ore is flumed more than a mile underground to the bottom of the 800-foot-deep central shaft.

Then the ore is screened to 8-mesh maximum, pumped to the surface with fluming water, and mixed to uniformity in 200,000-gallon holding tanks equipped with LIGHTNIN Side Entering Mixers.

Lightnin® Mixers MIXCO fluid mixing specialists

MIXING EQUIPMENT Co., Inc., 174-e Mt. Read Blvd., Rochester 3, N. Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

Better products, *faster*, from your Federal-Mogul Distributor:

Federal-Mogul Engine Bearings have what it takes to keep power at peak performance!

Be "quality" sure . . . use only Fm bearings on every oilfield power plant overhaul

Experienced mechanics know it doesn't pay to gamble with downtime or power loss in any way. That's why they insist on top-quality engine bearings for all engine overhauls. Federal-Mogul bearings have earned their stripes in rugged oilfield service, and the resulting favor of mechanics all over the world.

Precision engineering, metallurgical consistency and finest quality control, backed with unequalled availability, are a few of the reasons why Federal-Mogul engine bearings are first choice in the industry.

Your Federal-Mogul Distributor is ready to help you on all replacement needs. Call him!

FEDERAL-MOGUL ENGINE BEARINGS

BEARING FEDERAL Mogul SERVICE

FEDERAL-MOGUL SERVICE

DIVISION OF FEDERAL-MOGUL-BOWER BEARINGS, INC. • DETROIT 13, MICHIGAN

now... longer life, improved performance for pipelines, crude units... with Unicor

Are you aware of the tremendous difference a small amount of Unicor can make in pipelines and crude units?

This film-forming, oil-soluble inhibitor prevents all kinds of corrosion. Wherever Unicor has plated out on a surface, it gives protection to tanks, vessels and pipelines whether full, part-full or empty.

By adding a small amount of Unicor to your product—10-20 parts to a million—you prevent product contamination, profit-robbing corrosion; assure maintenance of full-flow capacity and output.

Furthermore, use of Unicor substantially reduces filter cleaning and replacements, scraping operations, power costs and expensive downtime.

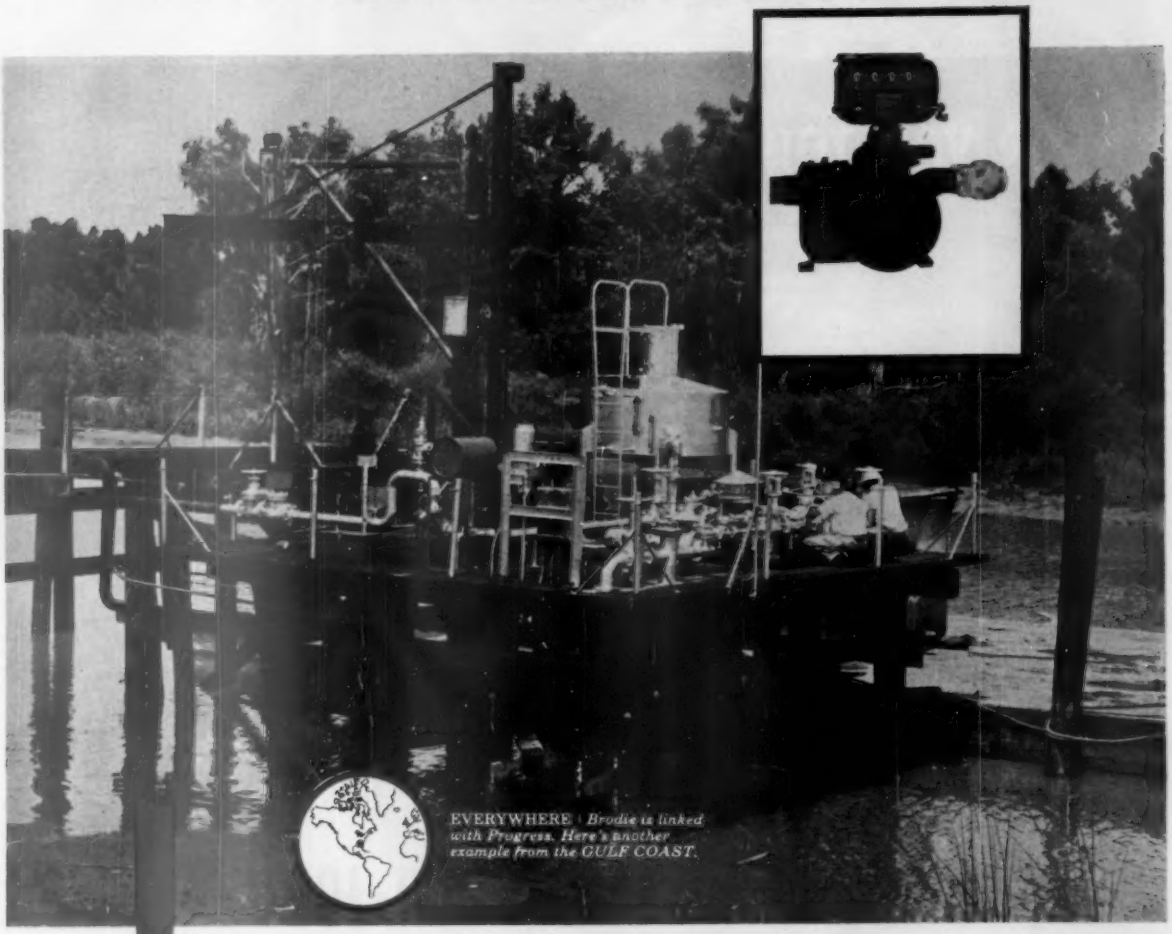
What Unicor does for tanks and pipelines it also accomplishes in crude units and other refinery equipment. For detailed information, write to our Products Department.

UOP®

UNIVERSAL OIL PRODUCTS COMPANY
30 Algonquin Road,
Des Plaines, Illinois, U.S.A.

UNICOR®

How BRODIE METERS and VALVES are used in Louisiana Marshes



Eleven skid-mounted Bi-Rotor Metering Systems used by Texas Pipe Line Company in Bateman Lake Field

These portable, skid LACT units incorporate Brodie B-53 *BiRotors* with built-in strainers and No. 531 Brodie Valves. The B-53 is equipped with a Brodimatic Printing Quantrol Counter and Automatic Temperature Compensator. Other meter accessories control the No. 531 valve, a proportional sampler and a transfer pump.

Heart of every system is the Brodie *BiRotor*—built to operate at full rated capacity under all conditions. Don't baby a *BiRotor*—use it!

004

RALPH N. BRODIE COMPANY
San Leandro, California, U.S.A.
CABLE ADDRESS: "BRODICO"

MT. VERNON, N.Y., 550 So. Columbus Ave.
DALLAS 7, TEXAS, 167 Parkhouse St.
SEATTLE 9, WASH., 221-9th Ave. N.
CHICAGO OFFICE: 1227 Circle Ave., Forest Park, Ill.
LOS ANGELES 22, CALIF., 5401 Sheila Street

BRODIE
METERS-VALVES

REPRESENTATIVES WITH STOCKS AND SERVICE FACILITIES IN ALL PRINCIPAL CITIES

TEAMWORK PAYS OFF!

...when you order your pipe through the

WHEATLAND PRODUCER-JOBBER TEAM

INSIST ON PIPE MADE IN U.S.A.

You can be sure this winning combination will supply you with steel pipe of unvarying high quality, job after job. And your Wheatland distributor sees to it that you get the pipe you need . . . on time!

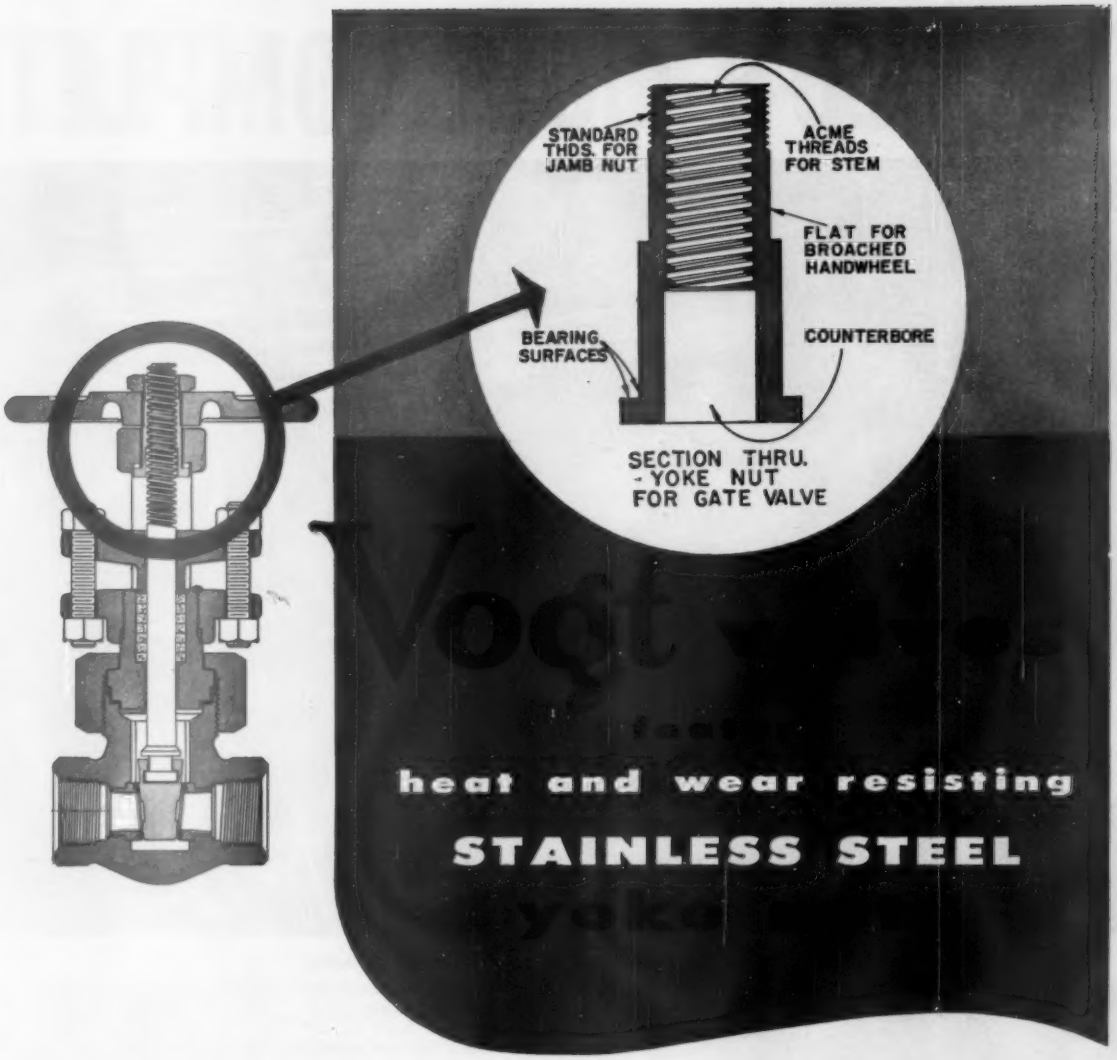
See your Wheatland Pipe Distributor for black or galvanized Wheatland Steel Pipe.

...pipe with the yearmark!

WHEATLAND STEEL PIPE

WHEATLAND TUBE COMPANY
Bankers Securities Bldg., Phila. 7, Pa.
MILLS: Wheatland, Pa. • Delair, N. J.

API LINE PIPE IN ACCORDANCE WITH AMERICAN PETROLEUM INSTITUTE SPECIFICATIONS



Heat and wear-resisting *stainless steel* yoke nuts in Vogt Valves give longer trouble-free service. We have proved this in our own "Torture Chamber," under constant and accelerated testing, as well as in tough service applications. They are made from a special stainless steel alloy having excellent bearing quality, matchless strength, and a melting point of approximately 2700°F.

The rotating gate valve yoke nut design, illustrated, has flats for a tight fit with the square broached hole of the handwheel. Non-rotating yoke nuts, for globe and angle valves, are of the same superior design and quality. Vogt GP Valves are available in a complete range of sizes from ¼" to 2" and rated 800 pounds at 850°F. and 2000 pounds at 100°F.

Catalog F-10 is available to you—please send request on your company letterhead. Address Dept. 24A-FO.

HENRY VOGT MACHINE CO.
P. O. Box 1918—Louisville 1, Ky.

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Cincinnati, Los Angeles.

Vogt GENERAL GP PURPOSE Vogt VALVES & FITTINGS

FORGED STEEL

VALVES

WORLD'S MOST COMPLETE

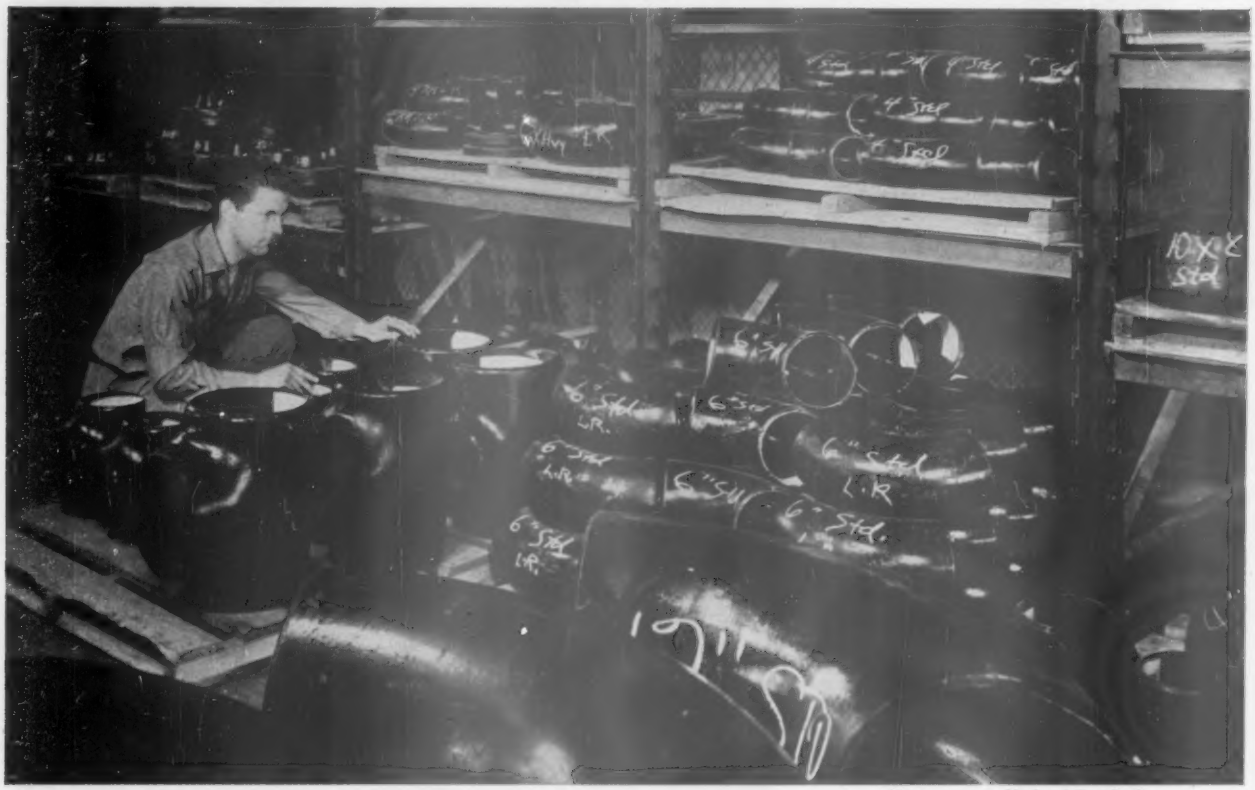
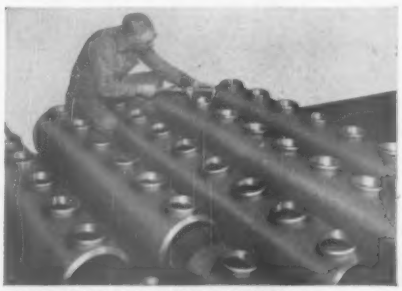


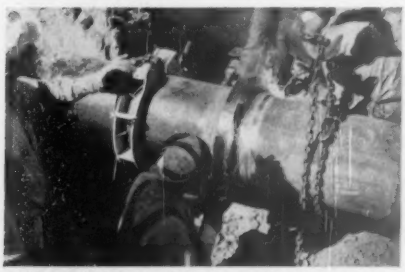
Photo courtesy National Supply Co.

TUBE-TURN WELDING FITTINGS AND FLANGES... in sizes, schedules, yield strengths and materials to match your needs. In carbon steel sizes from ½" to 42". Above photo shows part of stock of a Tube Turns' Distributor in the oil country.

TUBE-TURN VENTURI REDUCERS for minimizing valve costs.



TUBE-TURN MANIFOLD WELDING FITTINGS for simplifying multiple outlet construction.



TUBE-TURN ANCHOR FORGINGS for restraining pipe lines against end thrusts.

TUBE-TURN INSULATING FLANGES for preventing pipe corrosion by electrolytic action.

TUBE-TURN FULL ENCIRCLEMENT SADDLES for strong, safe "hot tap" connections.

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...available promptly from your TUBE TURNS' distributor

When you specify TUBE-TURN* pipe line products, you are assured *unsurpassed quality*, and you get *exactly* what you need *promptly*. Your nearby Tube Turns' Distributor carries the world's broadest line of pipe line fittings... more than 12,000 standard items, plus specials for every job. He can fill all your needs on one purchase order. No shopping around. No wasted time or red tape. *You save money*. Here is another *plus value* you get when you specify and buy TUBE-TURN products. Mail the coupon for pipe line catalog.

*"TUBE-TURN" and "tt" are trademarks of Tube Turns.

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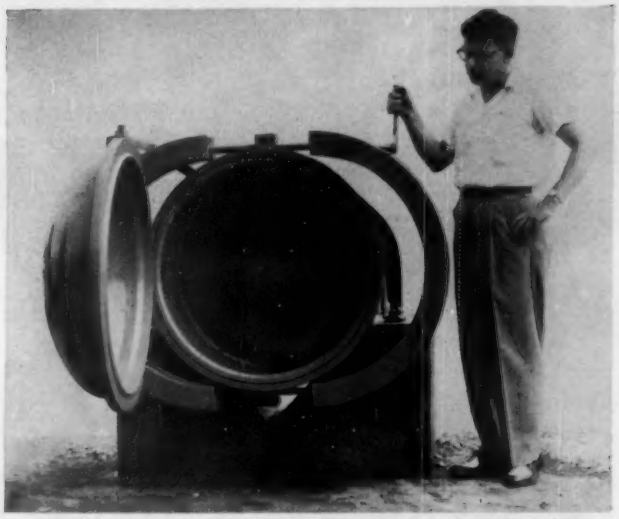

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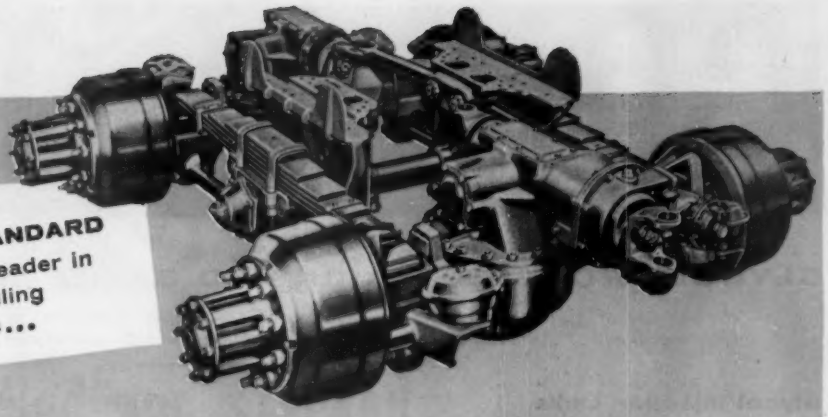

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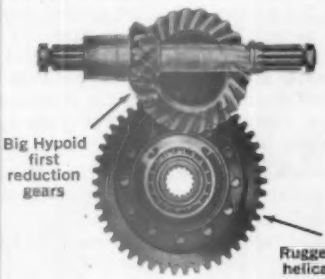
DOUBLE-REDUCTION TANDEMS LEAD IN TOP PERFORMANCE—LONG LIFE!

Timken-Detroit Heavy-Duty Tandems with Hypoid Helical Double-Reduction Gears are the big favorites for top performance and long life.
Here are some of the reasons why:

Rugged Hypoid-Helical Double-Reduction Gearing!

Balanced gearing—with two full-sized gear sets working in series to take an equal share of the load—provides a stronger power train with balanced gear set loadings and the widest range of ratios.



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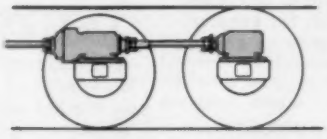
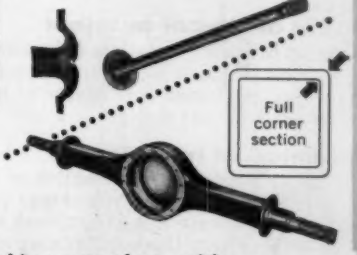
Allows differential action between the axles to compensate for worn or mismatched tires. Both axles do equal amounts of work . . . can be disengaged at any speed, giving positive through drive when better traction is needed. *Straight-Line Through Drive* eliminates prop shaft angularity . . . increases bearing and gear life, reduces maintenance.



"Torsion-Flow" Axle Shafts and Hot-Forged Housings!

More splines, Torsion-Flow forging, and patented heat-treating processes make Rockwell-Standard shafts the toughest in the industry. Housings are hot-forged from high carbon steel, and are rectangular shaped with full strength corners for greatest strength with minimum weight.



Timken-Detroit Double-Reduction Tandems come in a wide range of capacities—6 models from 34,000 to 65,000 pounds.

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ROCKWELL-STANDARD CORPORATION

Transmission and Axle Division, Detroit 32, Michigan

CONTACTOR

GLYCOL PROCESS DESIGN AND OPERATING INFORMATION

Proper use of glycols in well designed, correctly operated equipment is essential for efficient gas treating. Some of these important design and operating considerations will be discussed in this series.

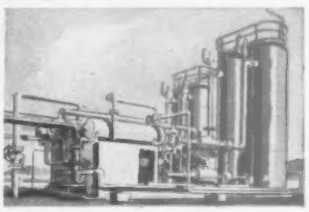
Glycol Injection Units

Units discussed in this issue of Allied Chemical Contactor are those using glycols to prevent hydrate formation when low temperatures are used to increase recovery of liquifiable hydrocarbons.

Type of Glycol for Use

Either ethylene or diethylene glycol may be used in glycol injection recovery units. Triethylene glycol is *not* recommended because of its high solubility in liquid hydrocarbons.

Both ethylene and diethylene glycol offer certain advantages depending on desired characteristics. Ethylene glycol has a higher vapor pressure, which means a greater vapor loss . . . yet it has a lower solubility in liquid hydrocarbons. Thus, losses are essentially equal for both chemicals. Ethylene glycol is less viscous than diethylene glycol, and its eutectic mixture with water has a lower freezing point than does the diethylene glycol eutectic.



Separation of Glycol and Hydrocarbon

Optimum temperature for separation of glycol and hydrocarbons is in the range of 40-60° F. High losses can occur if the streams are heated above 100° F prior to separation. At the other extreme – temperatures below 20° F – it is very difficult to separate glycol and hydrocarbon streams because they are practically insoluble. Entrainment of the glycol in the exit hydrocarbon stream will cause high losses of glycol. If it *is* mandatory to separate at low temperatures, long residence times or very efficient agglomerating separators should be used.

Amount of Glycol to Inject

To prevent hydrate formation, it is possible to inject as little as one-half gallon per hour per mmcfd; for greater dehydration, most operators prefer to inject one gallon of glycol per hour per mmcfd.

Mechanics of Injection

Use of spray nozzles for atomization of the glycol when it is introduced into the natural gas is recommended. Operating experience has shown that several joints of pipe will effect a very thorough mixing of glycol and gas, provided flow is in the turbulent region.

Care should be taken to prevent layering of glycol where the chiller is of the shell and tube type. Assure complete mixing of the glycol in the gas.

Care of Glycol

Like any process, good operation dictates that proper care be taken of the glycol used for hydrate inhibition. Frequent checks on the pH of the glycol should be made. Practically all of the degradation products of glycols are acids, being predominantly formic and acetic acid; and though none have been reported, it seems likely that dibasic acids could be produced by degeneration. If the pH of a glycol unit is not carefully watched the solution can become very acidic which will cause the solution to be corrosive. A buffer should be employed that will keep the pH at 7.2.

A black gum very often forms in glycol units. The presence of hydrocarbons seems to speed the rate of formation of this material, and hydrocarbons may be a reactant. The formation almost always occurs at a low pH and could be an ester (or even possibly a polyester). This material when deposited is very hard and brittle, but exists in the glycol as a very fine suspension. We believe that the removal and control of this material is essential to proper glycol unit operation.

In most of these systems a very convenient buffer is monoethanolamine. MEA is a fairly strong base and will yield soluble salts with the acids formed in these units. Another reason for the use of MEA is that it is a film former and will serve as a corrosion inhibitor. Care should be exercised when using MEA in this manner so that too much is not used. At a pH of around 8.5, a solution of glycol and MEA may foam very badly.

Another important step to be taken in the care of glycol solutions is the proper filtration of the solution. As mentioned, an accumulation of gum and silt in a glycol solution is an invitation to trouble. Glycol is a very difficult material to filter and one possible way might be to use a self cleaning type filter in combination with a packed filter. Longer and more complete operation would be obtained in this manner.

FOR MORE INFORMATION, look for future issues of Allied Chemical Contactor featuring articles on ethanolamines and glycols in gas treating operations.

We will gladly send technical data, delivery and price information on Allied Chemical Ethanolamines and Ethylene Glycols.

For specifications and local offices, see our insert in Chemical Materials Catalog, pages 475-482 and in Chemical Week Buyers Guide, pages 37-44.

BASIC TO AMERICA'S PROGRESS

Allied Chemical

NITROGEN DIVISION
Dept. C2-55-2, 40 Rector Street • New York 6, New York

2819

Here's the highballing crew that teamed up to pull and stack 6,000 feet of drill pipe in little more than one hour. Superintendent H. T. Love, and crewmen C. R. Williams, R. P. Williams and J. S. Light. Another member of the team—the International V-8 engine—is in the background.

6,000 feet pulled and stacked in 65 minutes with International V-8 engine

The Poole Well Service Co. of Midland, Texas is replacing 2½-inch tubing with 3½-inch for a sand fracturing operation on Humble's T & L lease. Sole power on their Wilson self-propelled servicing rig is an International UV-549 V-8 engine. With this dependable power the normal 4-man crew recently pulled and stacked 6,000 feet of 2⅞-inch drill stem in one hour and five minutes—an average of two stands per minute!

Your equipment, too, will perform more efficiently with smooth, dependable IH power. To adapt the engine to varying oil field requirements, there are fuel attachments for natural gas, combination natural gas and gasoline, and LPG; air compressor (engine mounted); hydraulic steering pump; Selectomatic torque converter or spring loaded clutch transmissions; exhaust condenser; top cylinder oiler; automatic safety shut-off; automatic radiator shutter; magneto ignition and gear driven mechanical governor. Your nearby International Engine Distributor or Dealer can give you product information and installation assistance on the complete line of 35 diesel and carbureted models—16.5 to 385 max. hp.

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Other advantages? KRALASTIC offers many. Its smooth internal surfaces offer less flow resistance. KRALASTIC pipe can be "welded" with a sleeve fitting and a special solvent. Yet where desired, it can be threaded and made up with standard KRALASTIC valves and fittings. Its unique combination of hardness and extreme toughness protects it against damage from foreign objects in the soil. Yet it can be easily cut to length with a hacksaw.

There are many more advantages to pipe made of KRALASTIC... advantages that have led to and been proved by more than 10,000 miles of pipe installed for everything from potable water to oil, brine, chemical, gas, and electric lines. Discover the advantages of this NSF Approved piping material yourself.

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W.R. GRACE & CO.
DAVISON CHEMICAL DIVISION
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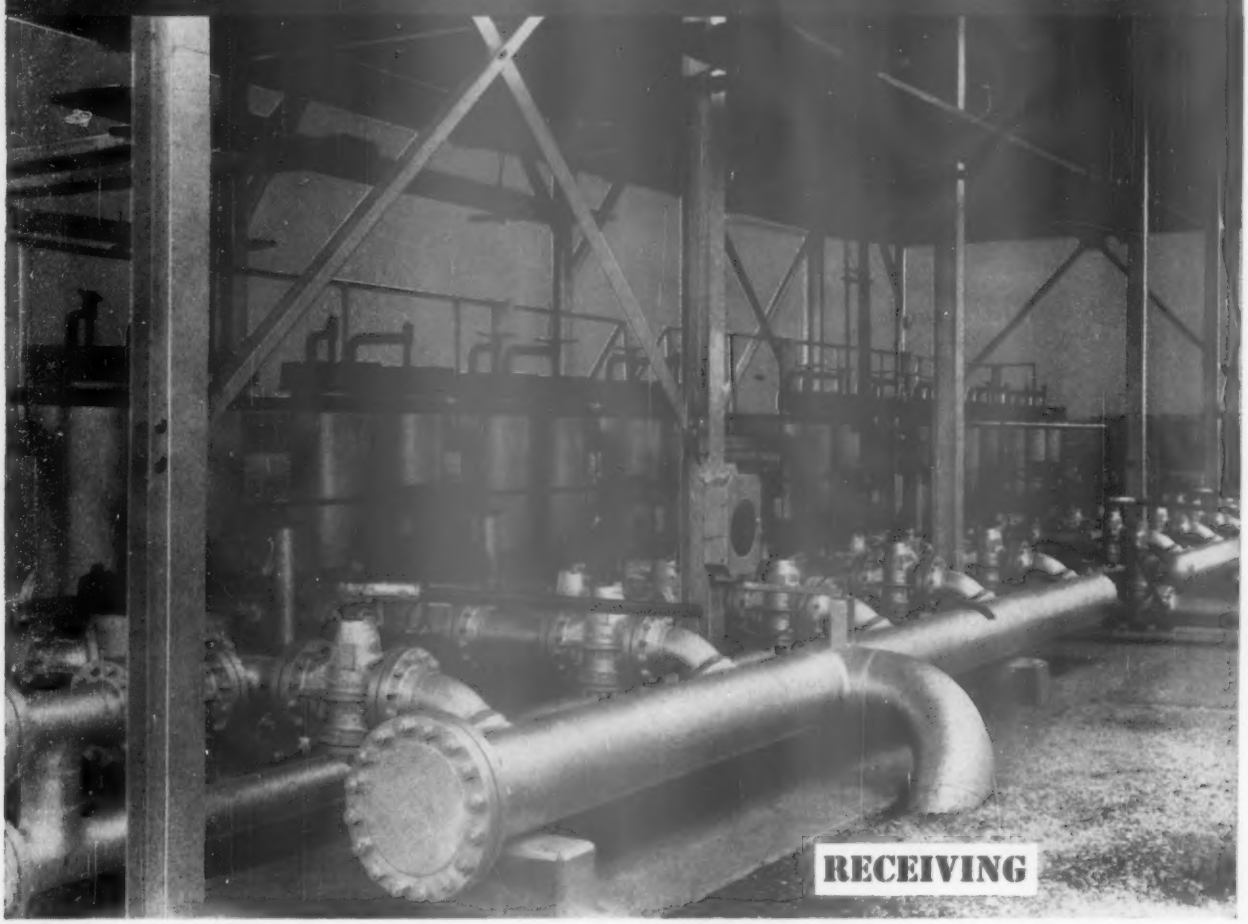
A major products pipe line company

counts 'em COMING



4-company oil "bank" keeps accurate ledgers on product deposits and withdrawals

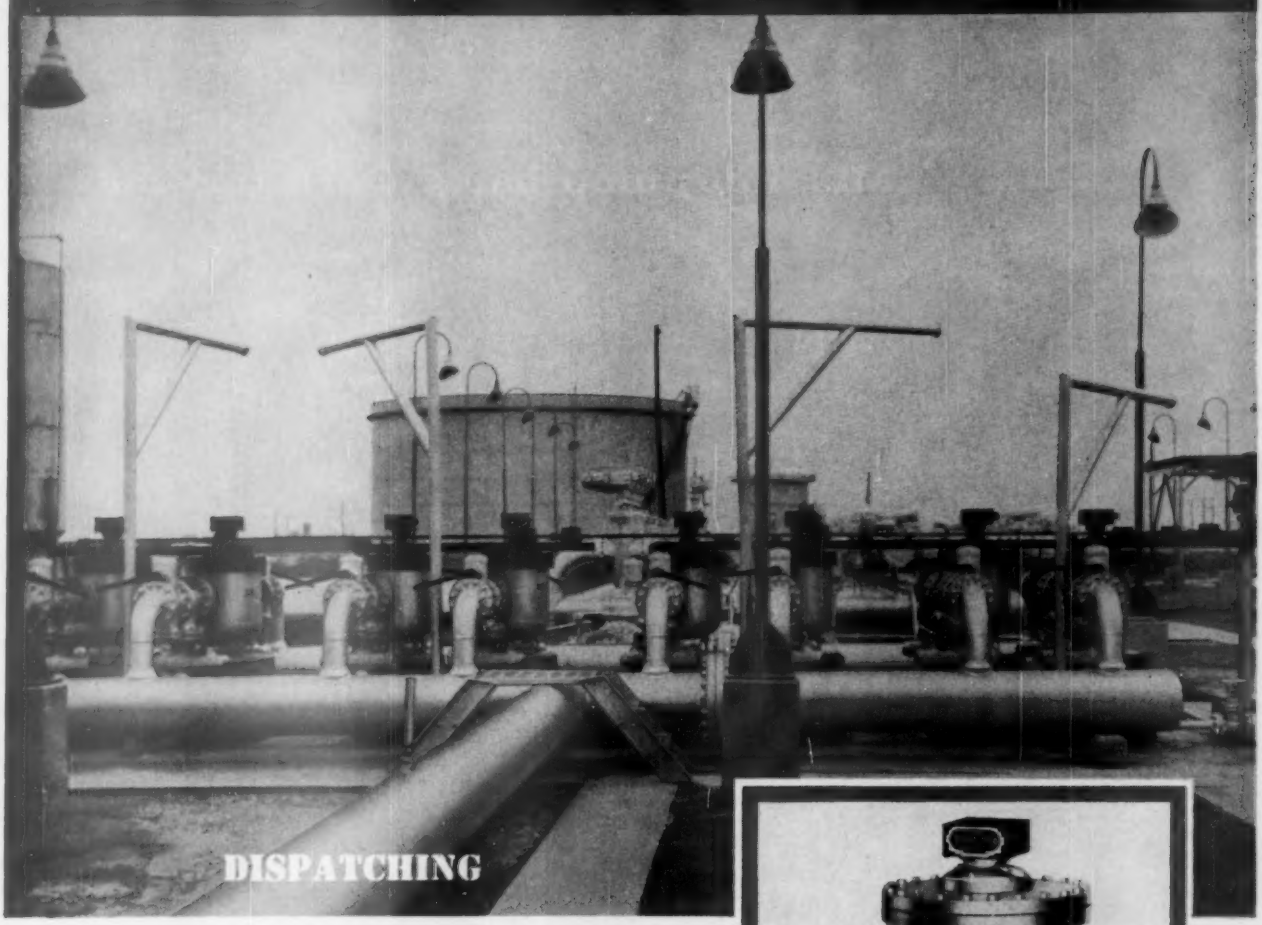
With four contributors working one terminal, accuracy is a must. And when this Gulf Coast installation was planned, the natural choice for keeping records straight was an A. O. Smith meter system.

The four lines feed through four separate A. O. Smith meter banks that register input within hundredths of a percent. A second set of meters measures and records individual deliveries from the product "pool" to the big 16-inch line.

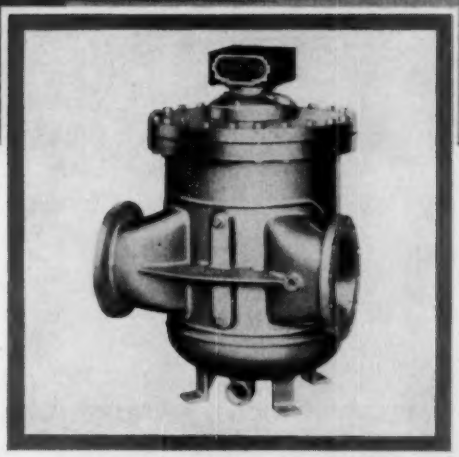
This modern replacement for old-fashioned tank gauging permits truly automatic operation — essential at such a complex installation. A. O. Smith meters provide for minimum use of tankage . . . save costly manpower . . . cut evaporation losses too. Capacity is 170,000 barrels.

This Gulf Coast terminal is just one example of job-site benefits that can be duplicated for you by A. O. Smith. For more information, contact your A. O. Smith meter man or write direct.

and GOING



A. O. Smith measures your needs — then recommends the metering setup that gives you the most accurate and economical service. Like this company, you can benefit by depending on A. O. Smith for meters.



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They Say—

Record tripped us up

Dear Sir:

In your April 11 issue in an article on "More Leasing Off California in the Mill," (p. 88) you state that Parcel D brought $23,711,538 or $6,175 an acre. And further, that this is far above any price paid in recent years for a lease either off California or in the Gulf of Mexico.

May I direct your attention to your article on page 91 of the August 17, 1959 edition: "Shell Oil Co. paid $26,105,000 for a 2,500 acre tract off Louisiana. The $10,442.08 per acre makes this the most expensive tract ever sold offshore, and perhaps the most expensive anywhere."

John L. Rankin, Manager
Bureau of Land
Management
New Orleans.

(Editor's note: Reader Rankin has caught us with our records down. We're breaking the news gently to our California editors that they no longer hold the record high-priced offshore lease.)

We're up to date!

Dear Sir:

I enjoyed your article on the new compact cars very much (OGJ, Mar. 28, p. 106). It shows how well you people keep up with current news and information.

Congratulations.

G. Harold Hubbard
Logan Oil Co.
Mount Pulaski, Ill.

Drake legend in jeopardy?

Dear Sir:

Please clear up the following problem for me, if you will. I question the generally accepted belief that the Colonel Drake well, drilled near Titusville, Pa., in 1858, was the first commercial oil well in the world.

Aside from activity that might have occurred in other countries, I know of two instances in the United States that pre-date the Drake well. Some 30 years before the Drake well, a well was drilled in Cumberland County, Kentucky, that struck oil. Since this well was drilled specifically for water

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Corrosion has always been a major problem in the petroleum industry. For nearly ten years, however, more and more oilmen have been specifying pipe made of Tenite Butyrate plastic to relieve this problem.

With pipe of Tenite Butyrate, corrosion worries are all but forgotten. This pipe, by its very nature, withstands the corrosive effects of sour crudes, salt water, and alkali soils. It gives year after year of worry-free service.

Pipe of Tenite Butyrate has other important advantages, too. Installation time and labor are minimized because this pipe is approximately 20% the weight of metal pipe of the same diameter, and is easily handled and transported. It is cut with a hand saw and joined quickly by solvent-welding. The smooth walls of pipe of Tenite Butyrate give up to 40% greater flow volume than does metal pipe for the same head loss. In addition, these glistening walls resist the accumulation of paraffin. All of these advantages produce substantial savings for users.

For more information plus names of companies producing Butyrate pipe and a complete range of fittings, write EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENN.

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Standard Magnesium Corporation

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rather than oil, it is possible that it could be disqualified.

However, Brigham Young sank a well near Evanston, Wyo., in 1848, specifically for the purposes of finding oil. The well went to 57 ft. and found oil. The oil was marketed in the area for lubricating wagon axles.

Therefore, it appears to me that legend of the Drake well is in serious jeopardy. While this little problem is not likely to have any effect on the present oil industry, it would nonetheless be interesting to have it more fully expounded.

Edgar B. Heylmun
Petroleum Geologist
Salt Lake City

(Editor's note: Many earlier instances of oil activity are known. It's easy to argue that wells were drilled for oil before Drake, but we can't argue with the fact that the oil industry started with the Drake well, then and there.)

Problem of missing episodes

Dear Sir:

I note that Mr. Outwater (Kenneth I. Outwater, Jr., Oklahoma City) in "They Say," Mar. 28 (p. 84) had trouble finding a few parts of a series you are running.

I have had this trouble also, but I believe this could be solved by indicating the location of the previous number in the serial with each new number.

This can always be followed up with a final series index, but allows a continuous method of locating a back weekly number... providing one keeps his Journals, which it seems almost every subscriber does. How about it?

E. A. Danehy
Blythe, Calif.

(Editor's note: This is a good point, and we'll keep it in mind hereafter when we publish consecutive articles on the same subject.)

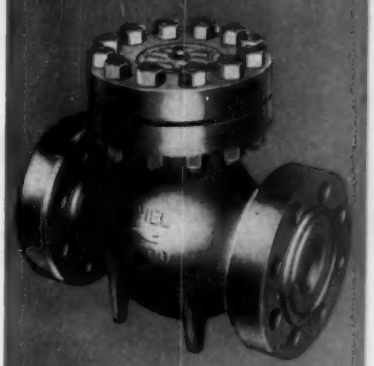
As Pure sees sloppy market

"There are factors not so generally recognized which we believe contribute greatly to market demoralization.

"The most important in our view is the government-imposed import program, which, on one hand, has stemmed the unbridled flow of foreign crude oil into the domestic market, and yet, on the other hand, has added to the woes of the industry.

"We do not agree with the granting of import quotas to landlocked refineries that had not been adversely affected by competition from refiners of foreign crude. Also, yielding to political pressure and following the small-

check the valve



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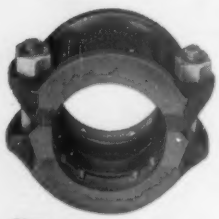

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business aid principle, quotas were granted to smaller refineries in almost inverse ratio to refinery runs of crude oil—that is, the smaller the volume the larger the percentage granted in the quota.

"These refineries have not only kept up but have increased their runs in order to build up even higher quotas which they sell to the seaboard refineries at bonuses approximating $1 per daily barrel. Many have used this bonus, at least in part, to cover their sales of products at cut prices."

Robert L. Milligan, Pure Oil Co., in a speech to company shareholders.

Letters to They Say should be addressed to The Editor, The Oil and Gas Journal, Box 1260, Tulsa, Okla.

CALENDAR

MAY

1-3 Texas Independent Producers and Royalty Owners Association, fourteenth annual membership meeting, Holiday Inn, Carlton and Blackstone Hotels, Tyler, Tex.

1-4 American Petroleum Institute, Division of Transportation, tanker conference, Seaview Country Club, Absecon, N. J.

2-3 Society of Petroleum Engineers of AIME, North Texas section, fourth biennial secondary recovery symposium, Wichita Falls, Tex.

4-6 Society of Petroleum Engineers of AIME, Rocky Mountain sections, and Canadian Institute of Mining and Metallurgy, petroleum division, joint meeting, Palliser Hotel, Calgary.

9-12 American Petroleum Institute, Division of Refining, midyear meeting, Statler and Sheraton-Cadillac hotels, Detroit.

9-12 Instrument Society of America, instrument-automation conference and exhibit, Civic Auditorium and Brooks Hall, San Francisco.

9-13 American Gas Association, distribution and transmission meeting, Jung and Roosevelt hotels, New Orleans.

11-12 University of Kansas, gas conditioning institute, National Guard Armory, Liberal, Kans.

11-14 Fluid Controls Institute, spring meeting, The Greenbrier, White Sulphur Springs, W. Va.

12-13 American Petroleum Institute, Division of Production, Pacific Coast district meeting, Biltmore Hotel, Los Angeles.

12-14 Kansas Independent Oil and Gas Association, annual meeting, Lassen Hotel, Wichita.

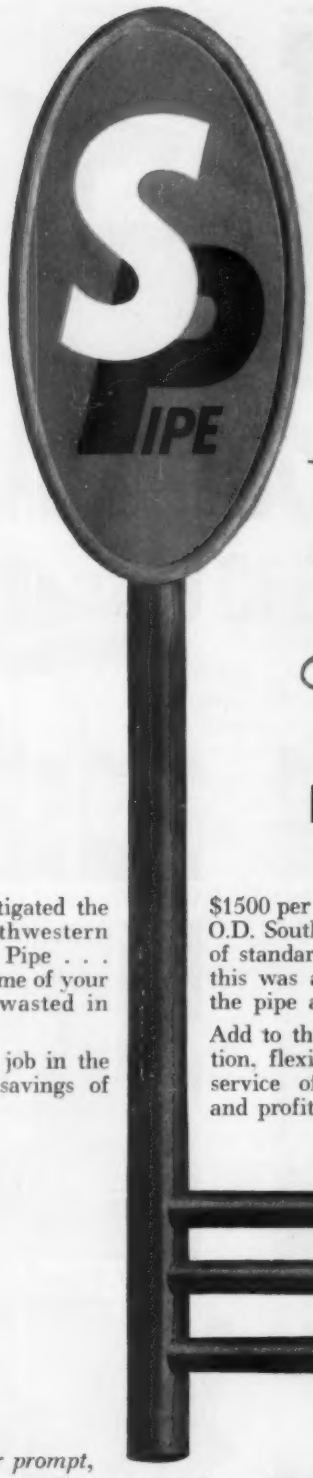
13-14 Southern Methodist University, School of Engineering, advanced technology seminar on heat transfer in electronics and direct conversion of heat to electricity, Dallas.

16-17 International Society of Professional Well Log Analysts, first annual meeting, Tulsa Hotel, Tulsa.

18-20 American Petroleum Institute, Division of Marketing, midyear meeting, Statler-Hilton Hotel, Cleveland.

22 Pennsylvania State University, short course in reservoir engineering, University Park, Pa. Term ends June 10.

22-26 Air Pollution Control Association,



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Gas gathering, Seagraves, Texas

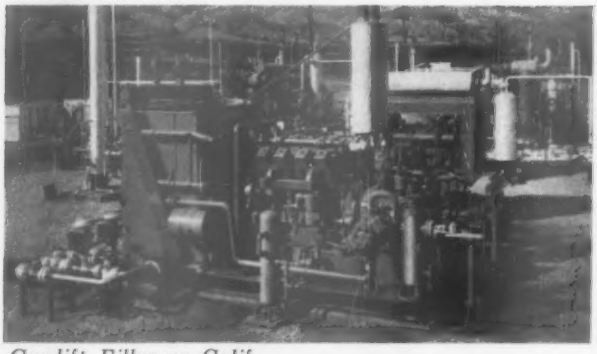
Gas gathering, Moore's Field, Texas

AGAIN and AGAIN...

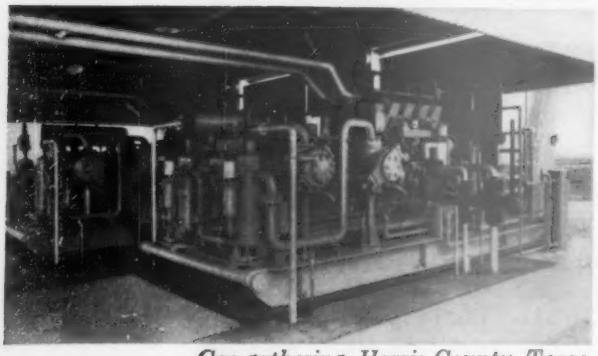
Gas gathering, Barataria, La.

Gas gathering, Clarkwood, Texas

Gas gathering, Tivoli, Texas



Gas lift, Fillmore, Calif.



Gas gathering, Harris County, Texas

Gas gathering, Raymondsville, Texas

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There are 15 sizes to choose from in the 100 to 350 bhp range. For full information, contact your nearest Clark representative and ask for CFA Bulletin No. 158 or CFB Bulletin No. 171. Or write to Clark Bros. Co., 1031 Lincoln Ave., Olean, N. Y.

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annual meeting, Netherland-Hilton Hotel, Cincinnati.

23-24 American Gas Association, production meeting, Roosevelt Hotel, New York City.

23-26 American Society of Mechanical Engineers, oil and gas power conference and exhibit, Muehlebach Hotel, Kansas City.

24-25 Western Petroleum Refiners Association, computer conference, Ben Milam Hotel, Houston.

24-26 American Right of Way Association, annual seminar, Shoreham Hotel, Washington.

25-27 Pacific Coast Gas Association, accident prevention and transmission conference, Hotel Utah, Salt Lake City.

25-28 American Association of Petroleum Geologists, western Canada regional meeting, Banff Springs Hotel, Banff, Alta.

26-27 Natural Gas and Petroleum Association of Canada, meeting, Niagara Falls, Ont.

JUNE

1-3 Texas College of Arts and Industries, fifteenth annual short course on gas technology, sponsored by Southern Gas Association, Kingsville, Tex.

1-3 West Virginia University, fifth annual Appalachian underground corrosion short course, Morgantown, W. Va.

2 Pennsylvania Grade Crude Oil Association, annual meeting, Pennhills Club, Bradford, Pa.

2-3 Kentucky Oil and Gas Association, annual meeting, Phoenix Hotel, Lexington.

5-9 American Society of Mechanical Engineers, summer annual meeting, Dallas.

5-10 Society of Automotive Engineers, summer meeting, Edgewater Beach Hotel, Chicago.

9-11 Manufacturing Chemists' Association, annual meeting, The Greenbrier, White Sulphur Springs, W. Va.

13-15 American Association of Cost Engineers, annual meeting, Rice Hotel, Houston.

13-15 Chemical Institute of Canada, annual conference and exhibition, Chateau Laurier, Ottawa.

13-15 Interstate Oil Compact Commission, midyear meeting, Statler Hilton Hotel, Detroit.

15-16 Western Petroleum Refiners Association, Mid-Continent regional technical-industrial relations meeting, Hotel Lassen, Wichita.

19-22 American Institute of Chemical Engineers, Instituto Mexicano de Ingenieros Quimicos, joint meeting, Hotel Del Prado, Mexico City.

22-25 Canadian Gas Association, annual meeting, Manoir Richelieu, Murray Bay, Quebec.

22-25 American Association of Petroleum Landmen, national convention, Ambassador Hotel, Los Angeles.

25-29 Petroleum Equipment Suppliers Association, annual meeting, Banff Springs Hotel, Banff, Alta.

25-July 5 First International Congress for Automatic Control, Moscow, U.S.S.R.

26-28 North American Gasoline Tax Conference, annual meeting, southern region, Eden Roc Hotel, Miami Beach.

26-July 1 American Society for Testing Materials, annual meeting and exhibit, Chalfonte-Haddon Hall, Atlantic City, N. J.

27-28 Michigan Gas Association, Mackinac Island, Mich.

JULY

28-30 American Petroleum Institute, Division of Production, Eastern district meeting, The Greenbrier, White Sulphur Springs, W. Va.

AUGUST

3-5 Wyoming Geological Association, field trip to Snyder basin and Wind River Mountains, Casper.

14-19 National Congress of Petroleum Retailers, Inc., annual session, Shamrock-Hilton Hotel, Houston.

15-17 American Society of Mechanical Engineers, American Institute of Chemical Engineers, heat transfer conference and exhibit, Statler Hilton Hotel, Buffalo, N. Y.

15-26 Sacramento State College, summer institute on nondestructive testing, Sacramento, Calif.

22-26 Gordon Research Conference, catalysis, Colby Junior College, New London, N. H.

29-31 Appalachian Gas Measurement Short Course, University of West Virginia, Morgantown, W. Va.

SEPTEMBER

6-7 Chemical Institute of Canada, organic chemistry division conference, Edmonton.

7-9 American Society of Mechanical Engineers, joint automatic control conference, Massachusetts Institute of Technology, Cambridge, Mass.

8-9 National Research Council, Chemical Institute of Canada, tenth Canadian high polymer forum, Alpine Inn, Montreal.

8-10 Chemical Institute of Canada, western regional conference, Regina.

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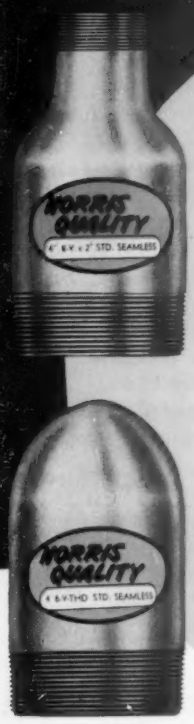

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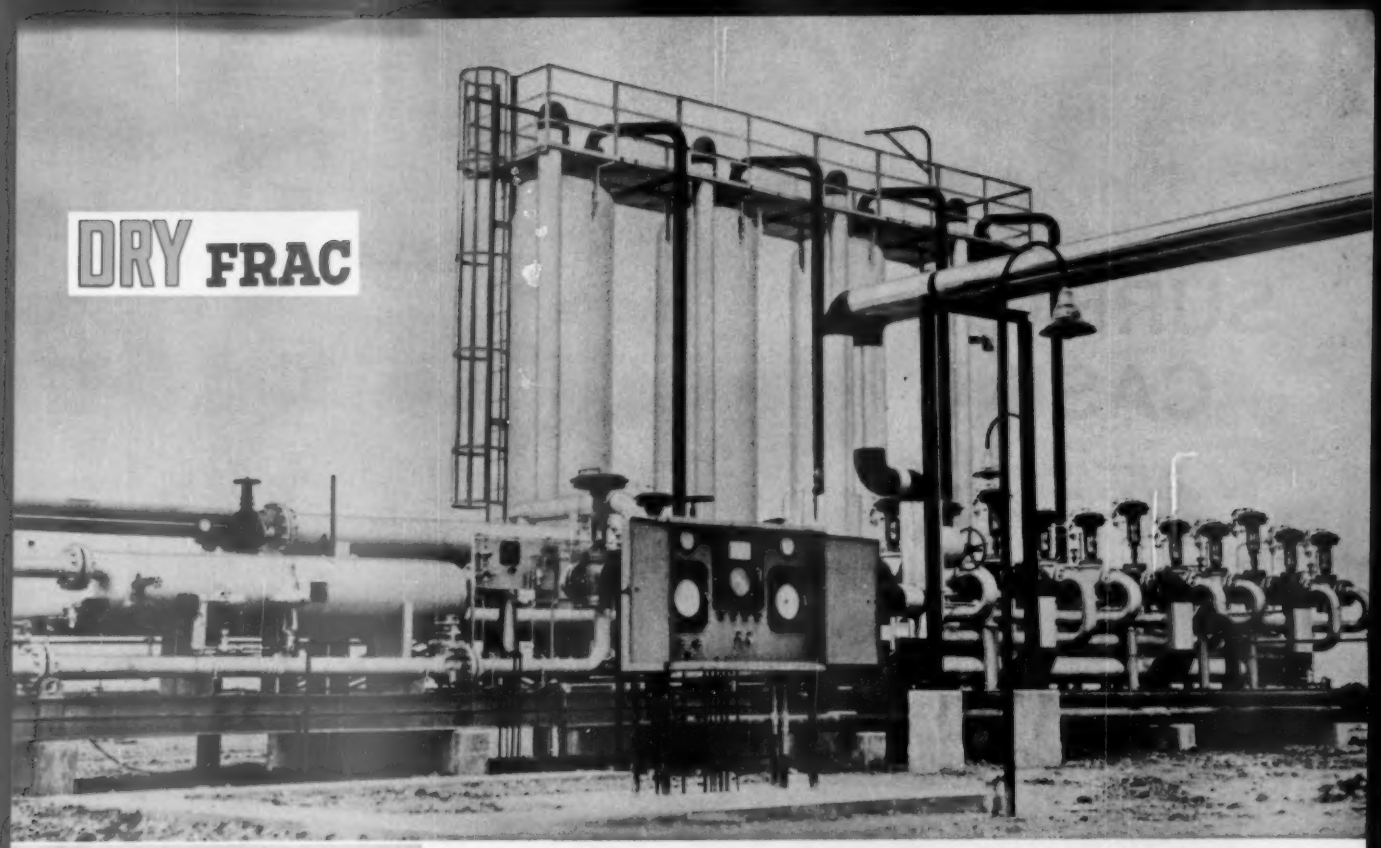

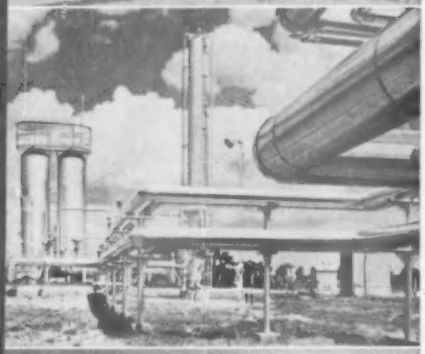

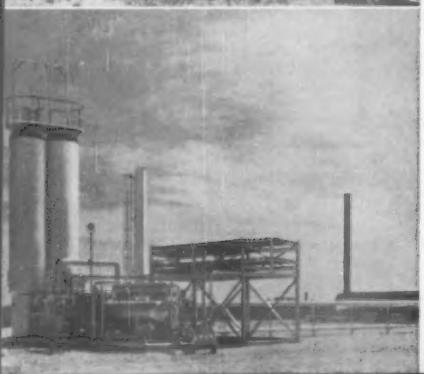

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50 years ago

May 6, 1910

California's biggest oil deal to date has been consummated with the purchase by Kern River Oil Fields of California, Ltd., a new British corporation, of Imperial Oil Co.'s 480 acres, and Thirty-three Oil Co.'s 160 acres of Section 33-28-28, at Kern River. The purchase involves 127 producing wells with yearly output of 2,000,000 bbl. One-third of the acreage remains to be developed. Total purchase price was $7,500,000. The new company becomes the second-largest operator at Kern River, next to Associated Oil Co.

United States Supreme Court affirms mandates of state courts ousting Standard Oil Co. from doing business in Tennessee. Violation of state's antitrust statutes was charged.

25 years ago

May 2, 1935

Michigan's most modern cracking unit, and first to be erected by any independent refinery, goes into operation at Naph-Sol Refining Co.'s plant in Muskegon oil field. At the same time, Michigan's daily average oil production for the week climbed above 39,000 bbl. to set a new all-time record.

Oklahoma's largest gasoline-plant-construction project in several years gets under way in booming Fitts field, in Pontotoc County. The new plant is a joint operation of J. E. Crosbie, Inc., and Warren Petroleum Co. It is of the combination compression-absorption type, capable of processing 10 to 20 M.M.c.f. of gas daily with recovery of 25,000 gal. of liquid, including all standard grades of gasoline.

10 years ago

May 4, 1950

Sunray Oil Corp. and Barnsdall Oil Co. directors sign agreement of merger in one of the oil industry's largest company consolidations in several years. Special meetings of stockholders of the two companies are called to pass on the subject.

Levelland gasoline plant in West Texas' Hockley County is termed industrial monument to the success of the American system at special dedication ceremonies marking its formal opening. New gas-conservation project, operated by Stanolind Oil & Gas Co. with 11 participating owners, processes 40 M.M.c.f. of gas daily with yield of 130,000 gal. of liquid products.

Phillips Petroleum Co. reveals plans for 30,000-bbl. catalytic cracking unit to be added to its processing facilities at Phillips, near Borger, in the Texas Panhandle. Present plant has crude-oil capacity of 56,000 bbl. daily.

JOURNALLY SPEAKING

Capital Whirl

(The regular conductor of this column is trying to work himself out of a job by encouraging other staff members to contribute. The following is printed without comment other than that we used to be Washington editor of the Journal, and LaMotte can have the job.)

THE LIFE of a Washington oil editor is a ball.

Washington is a city that specializes in long lunches, frequent cocktail parties, and gala formal receptions. It is one of the prime crossroads of the world, a meeting place for the greats, the near-greats and the would-be greats.

So, while Journal editors in the Tulsa office are slaving over hot copy, worrying about magazine covers, inside layouts, etc., the Washington editor is strolling about, cocktail glass in hand, rubbing elbows with foreign ambassadors, U. S. senators, Cabinet officials and others.

Thus a Washington oil editor's weekly calendar can look like this:

Monday—Luncheon at the Hay-Adams House for Oil Union President O. A. (Jack) Knight and other OCAW officials. Interview Knight about what's cooking on the oil labor front.

Tuesday—Lunch with staff man of Committee for Oil Pipelines. At 5 p.m. go to open house at Gulf's new Washington quarters; talk with W. K. Whiteford and other Gulf brass. At 7 p.m., dash home to don tuxedo and hurry back into town with wife for reception at Venezuelan embassy. Chat with Dr. Perez de la Cova, Venezuela's long-time oil specialist in Washington. Late supper with friends. Home by 1 a.m.

Wednesday—Luncheon at Presidential Arms, Commerce Secretary Fred Mueller the principal speaker. At 5 p.m., back to Press Club for drinks and chat with a former ambassador who is now in an oil consulting firm specializing in Libya. Late getting home to dinner; welcome not too warm.

Thursday—Lunch with IPAA Washington representative. Talk gas bill. Dinner with visiting fireman from Texas.

Friday—Lunch with an expert who has written a paper about the future trends in uses and prices of coal, oil, and gas.

Saturday—7:30 a.m. (groan), annual Sigma Delta Chi breakfast for newspaper editors with government brass as guests. These include Vice President Nixon, several U. S. Supreme Court justices, numerous senators, congressmen, and cabinet members. Journal's guest: FPC Chairman Jerome Kuykendall.

Saturday afternoon—Relax on the living-room couch, ignoring garden tools suggestively laid out in the back yard by Mrs. Washington Editor.

This, as you can see, is really living it up. But there are a few drawbacks. For instance, one's publisher is likely to have the old-fashioned view that a Washington editor is supposed to find time to do a little work.

So, in between leisurely luncheons and cocktail parties, the Washington oil newsman scurries around the Washington alphabetic jungle in an effort to find out what the OCDM is planning to recommend for tankers, what the probe of FPC amounts to, whether Congress is going to act on a half dozen bills affecting oil, who the Oil Import Appeals Board is going to turn down next, when the Supreme Court is likely to rule on the offshore boundary issue, and whether the FPC will accept the plan Phillips proposed to settle the long-standing gas rate case.

Furthermore, although cocktail parties can be fun, standing up at one for a couple of hours at the end of a long day can be tough on aging arches.

And glamorous evening receptions would be more enjoyable if one knew more foreign languages and were it not for the thought of tomorrow morning's alarm clock.

There are times when an editor passes up some event for a relaxed, shoes-off evening at home with his family. Naturally, that is when some government official at a cocktail party springs with a juicy oil news tidbit, or tips a rival reporter to a good story.

Come to think of it, the chaps in the home office have a pretty soft touch.

—Clyde LaMotte

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FPC can't be isolated from industry contacts

THE CONGRESSIONAL INVESTIGATION of allegations of "influence" on Federal Power Commissioners by some gas companies may or may not turn up anything substantial and improper. We hope it doesn't, for the sake of an honorable agency and an honorable industry.

The individuals involved can doubtless take care of themselves. Our chief concern is that the public will get the idea that any contact between a federal official and the oil and gas industry is synonymous with corruption.

Neither a regulatory body nor the industry it regulates can function efficiently in an atmosphere of deep suspicion and cynicism, with each treating the other like a leper.

BRIBERY, GRAFT, AND VENALITY are, of course intolerable. But in its zeal to prevent these, Congress could hamstring FPC and similar agencies by quarantining them in antiseptic and monklike cells.

"Influence" may be a dirty word in Washington. But there is something worse in government. That is a sterile, stagnant, indecisive bureaucracy, out of touch with business life, avoiding actions that might offend someone.

A public office is a public trust, but the converse is also true. The public must trust its officials to withstand the normal pressures of business and politics without hedging them about with good-conduct rules or having investigators check every waking moment.

Regulators wear two hats. They have both legislative and judicial functions. A type of industry contact improper during the judicial phase may be essential to the legislative side of the job. Businessmen and congressmen may have difficulty distinguishing the two, but the commissioners should not.

A commissioner should have the intelligence to tell when an industry contact is proper and when it is not, and the integrity to avoid, ignore, or rebuke approaches that may be improper attempts to influence him.

A REGULATOR MUST LIVE close to the industry he regulates. If he is of the proper caliber to have the job in the first place, the more intimately he understands the industry the better he can regulate it. Communication between industry and its regulators must not be prohibited.

There should be no suspicion of impropriety when gas men mingle socially with FPC personnel or extend them the courtesies normal to business life. And inspection of gas facilities—even in company planes—should be an aid to good regulation rather than a deterrent.

There is a line between frank cordiality and sinister influence. But it can't be defined by written regulations. Both businessmen and public officials should have the good sense to appreciate this line and to avoid stepping over it.

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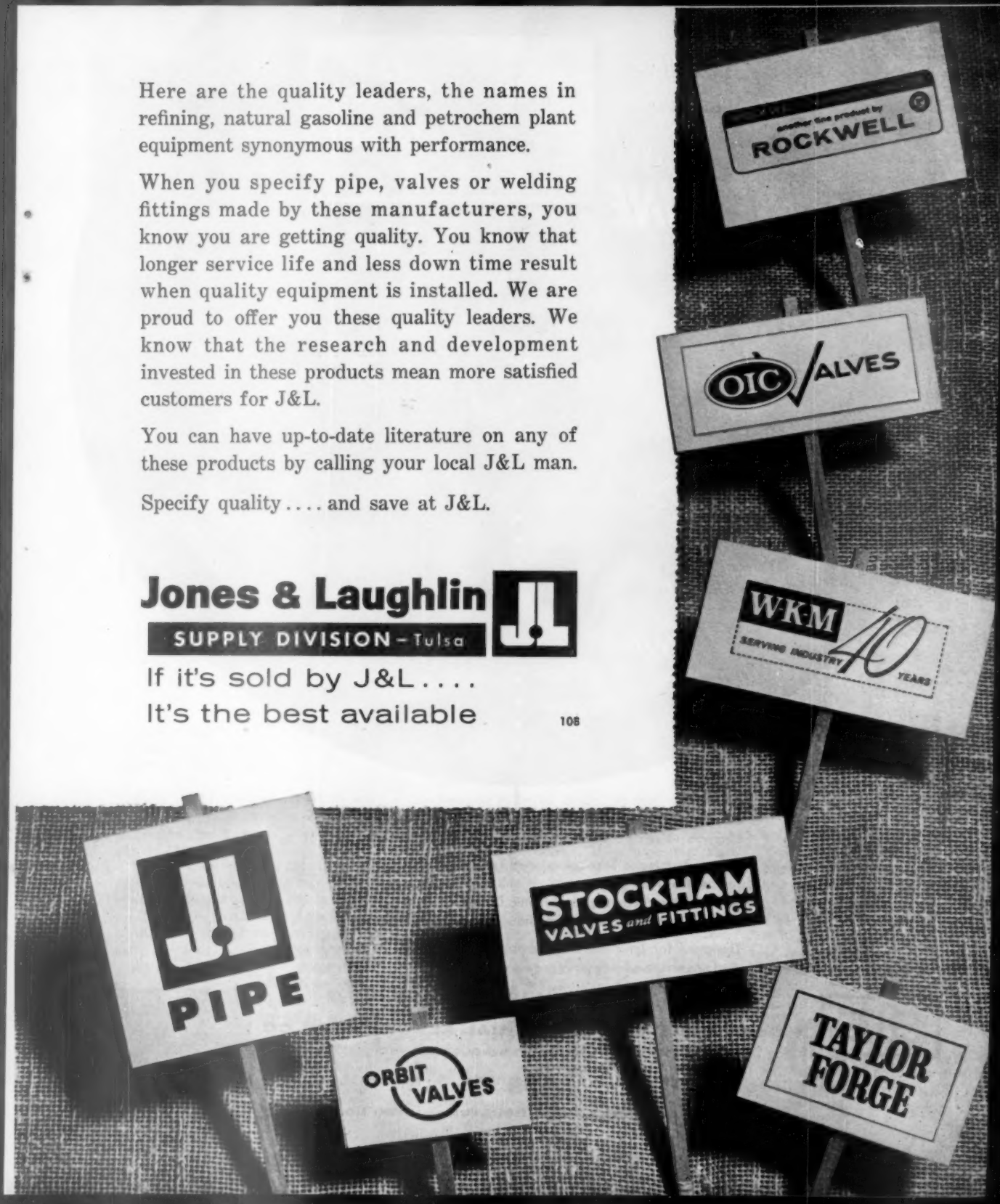

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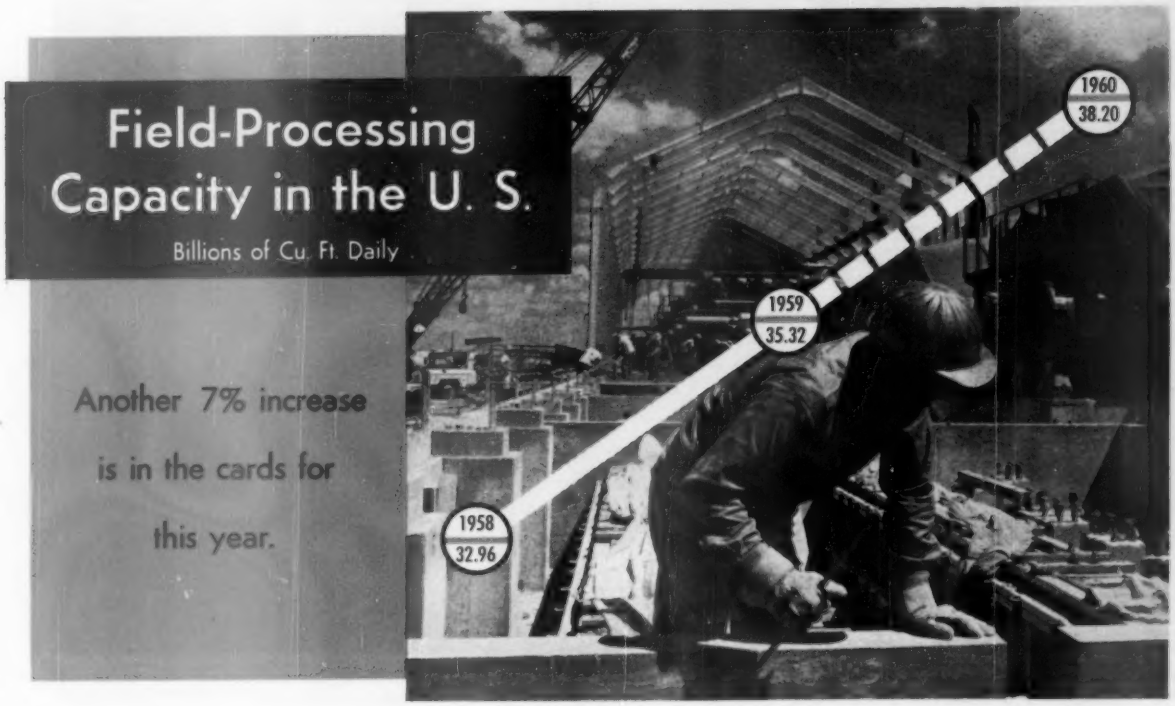


Field Processing: More Growth Ahead

• After chalking up a healthy increase in natural-gas capacity during 1959, the pace isn't going to slow down. Another big boost this year is assured by new gas-processing projects in the mill.

Hugh S. Pylant
Petrochemical and
Gas-Processing Editor

THE VERY big and very little are playing important roles in the steady growth of the nation's field-processing capacity.

One definite trend in today's field-processing business is the fast growth of small-capacity gasoline plants. These short-cycle, solid-bed adsorption plants have turned the processing of lean gas into a profitable business.

At the other end of the construction scale is the giant, economy-sized plant. Some of these plants turn out more liquids in a day than all the small plants put together.

The growth of these big and little plants, plus the increased capacity of the standard gas-processing plants, hiked the natural-gas capacity of the nation's field-processing plants 7% last year. Projects under way or planned point to a similar increase this year.

Information gathered as part of the Journal 1960 field-processing survey shows there are 152 of the small lean-gas plants in operation. Manufacturers of these units predict this total will almost double by the end of the year.

These existing lean-gas plants have a total gas handling capacity of approximately 3.5 billion cubic feet daily. They are capable of producing 510,000 gal. of liquids daily. While some of these units are designed to produce LPG and gasoline, about 95% turn out only gasoline consisting of isopentane and heavier.

The Journal's survey shows there are 10 of the giant plants now in operation. These plants, with capacities ranging from 400 to 1,000 million cubic feet daily, are mostly located on cross-country transmission lines where they economically process gas as lean as 0.50 to 0.75 gal. per M.c.f.

This year's field-processing survey also shows:

... **Plant capacity** increased 2.56 billion cubic feet in 1959. Total U. S. plant capacity was more than 35.52 billion cubic feet daily as of January 1, 1960. The 36 new plants and expansions under way, planned, or just recently completed are expected to boost total capacity to an estimated 38.20 billion cubic feet per day, an increase of 7.6% by January 1, 1961.

... **Liquid production** jumped 3,819,300 gal. per day last year. The 553 U. S. plants responding to the survey averaged 41,180,700 gal. daily during 1959. This could climb above

WORLD'S LARGEST natural-gasoline and cycling plant will be at King Ranch in Kleberg County, Texas. The plant will have a capacity of 800,000 M.c.f. daily when completed late in 1960. Liquid recovery will be 1,176,000 gal. daily.

45,000,000 gal. per day due to the new capacity that will be added this year.

...More natural gasoline is being upgraded into a more desirable product. As the demand for higher octane motor fuel has increased, the market for natural gasoline has declined and new methods have been sought to raise its value. As a result of this search, catalytic reformers and pentane isomerization units have been installed in nine of the plants surveyed this year to up octane rating of their gasoline.

...Deeper extraction in conventional oil-absorption plants is growing. Operators are using temperatures as low as −40° F. and light absorption oil in the range of hexane. It is common for these plants to recover 80 to 90% of the propane contained in a gas stream and essentially 100% of all heavier components.

The big plants . . . Several big plants are now under construction or were recently completed.

Humble Oil & Refining Co.'s King Ranch plant in Kleberg County, Texas, is scheduled for completion late in 1960. It will have capacity of 800 million cubic feet daily. Liquid production will average 1,176,000 gal. per day.

Goliad Corp.'s $12-million plant in Vermilion Parish, Louisiana, will go on stream in the fall of 1960 with a gas capacity of 450 million cubic feet daily and liquid production of 295,000 gal. per day.

The Journal's Survey

A COMPLETE rundown on the various products being turned out by field-processing plants is included in the Journal's exclusive survey for the first time.

This breakdown is included in the tables starting on p. 107 of this issue of the Journal. Also listed are the capacities, locations, and production of U. S. natural-gasoline plants and all Canadian plants.

Some companies did not report throughput of natural gas. In such cases, capacity figures were used to arrive at state, province, and national totals. Therefore, figures shown are higher than actual throughput.

Runnels Gas Products Corp., subsidiary of Union Texas Natural Gas Corp., is boosting its Eunice, La., plant from 450 to 800 million cubic feet daily. Completion is expected early in 1961.

Union Texas Natural's Rayne, La., transmission-line plant was recently put on stream with a throughput of 700 million cubic feet daily.

Canada gains . . . Capacity of field-processing plants in Canada increased by 539 million cubic feet in 1959. The 25 plants responding to the survey reported total capacity of more than 1.55 billion cubic feet per day as of January 1, 1960.

Several new projects currently under way or planned will boost the capacity to an estimated 1.88 billion cubic feet by January 1, 1961. The largest is British-American Oil's plant in Homeglen-Rimbey and Westerose South fields in Alberta. Scheduled for completion November 1, 1960, the plant will have capacity of 326 million cubic feet of gas daily.

Average daily liquid recovery in the Canadian plants during 1959 was 996,990 gal., but the new projects will make possible production of more than 1,400,000 gal. daily next year.

Geologists See Hopes for Atlantic Coast Oil

LIKE HUNTERS on the trail of a new quarry, 2,000 members of the American Association of Petroleum Geologists last week took a first serious look at the Atlantic coastal plain of the United States as a possible source of oil.

One entire session of the association's forty-fifth annual meeting was devoted to a study symposium of the chances for success on the East Coast.

"We think oil must be there, if for no other reason than it's the largest area in the country in which oil and gas have not been discovered." That was the frank opening gun in the discussion, launched by James Trumbull of the U. S. Geological Survey.

In the long coastal area, stretching from Florida northeast to Connecticut, only 200 test wells have been drilled. All were dry. But as more data accumulates and geophysical investigation continues, oil finders become more convinced that chances are at least fair that discovery may come.

Trumbull, confining himself to the submerged Continental Shelf, cited the presence of 17,000 ft. of favorable sediments underlying a 1,100-mile long tidelands strip, as the chief factor favoring oil there.

"It appears from several points of view to be a likely petroleum target," Trumbull said. "The presence of coarse detrital material on the subsurface, the probability of updip Jurassic and Cretaceous wedgeouts, buried shorelines, downfaulted basins, and large regional structures lend credence to the theory of accumulation."

The best chances for oil pools would lie in the Mesozoic section, according to Trumbull. "As for the Paleozoics," he said, "when last seen, they were headed out to sea."

Florida's L. D. Toulmin
. . . speaking at the AAPG meeting.

Turning to the emerged plain, where all drilling to date has been done, Richard V. Dietrich of Virginia Polytechnic Institute, Blacksburg, Va., took up the discussion.

Dietrich described the basement rocks that underlie the Atlantic seaboard, and pointed to further possibilities of oil accumulation in these rocks themselves, or in weathered and detrital material associated with them.

The deepest hole yet drilled on the coast was Esso's 1 Hatteras Light well, which went to 10,054 ft. and found top of the basement at 9,954 ft. subsea. Some tests have found the basement rocks weathered to a depth of as much as 150 ft., he said. The basement surface dips seawardly at an average 35 ft. per mile until it reaches the subsea 2,250-ft. contour; thereafter, it steepens to 100-125 ft. per mile.

A third authority in the field, H. E. Legrand of the USGS, summed up the geological considerations involved in possible future exploration of the Atlantic Coastal plain.

He described four principal regional structures which influence the entire sector: The Carolina's Cape Fear arch, Florida's Ocala uplift, Maryland's Salisbury embayment, and the Southeast Georgia basin. All are well known. But an even greater importance lies in smaller structures yet to be found that stem directly and indirectly from these huge regional ones.

Six more speakers added the benefit of their knowledge to the coastal-plain symposium.

L. D. Toulmin, of Florida State University, described the connection of the Atlantic and Gulf Coastal Plains through stratigraphic studies along the Chattahoochee river.

Other speakers outlined geophysical, gravity, and aeromagnetic profiles that lend further hope to oil and gas discovery on the coast.

The general impression carried away by the oil finders was that the chances are good, but the risks are high. More drilling is needed to produce more subsurface dope, for the overall conclusion was that only by tracing subsurface knowledge to the surface, by intensive geophysical work, and by drilling more wells, will the industry find that elusive Atlantic oil.

Union's Shale-Oil Plans Are on the Shelf

THE COMBINATION of a low depletion allowance and depressed crude prices has resulted in the shelving of shale-oil process plans of Union Oil Co. of California.

An experimental shale retort, operated by the company near Rifle, Colo., will be dismantled.

The efficiency of Union's patented retorting process was demonstarted by the research plant, A. C. Stewart, Union senior vice president, says. However, low crude prices and the tax picture make the process uneconomic at this time.

The depletion allowance on shale ore is now 15%. Union has urged that a 27½% allowance be adopted for shale oil, which is obtained by retorting the ore.

If these factors should change, or in the event of a national emergency, Union says it can move into commercial oil-shale operation immediately. A commercial retort would be constructed on the 55,000 acres of shale lands it owns in the Rifle area.

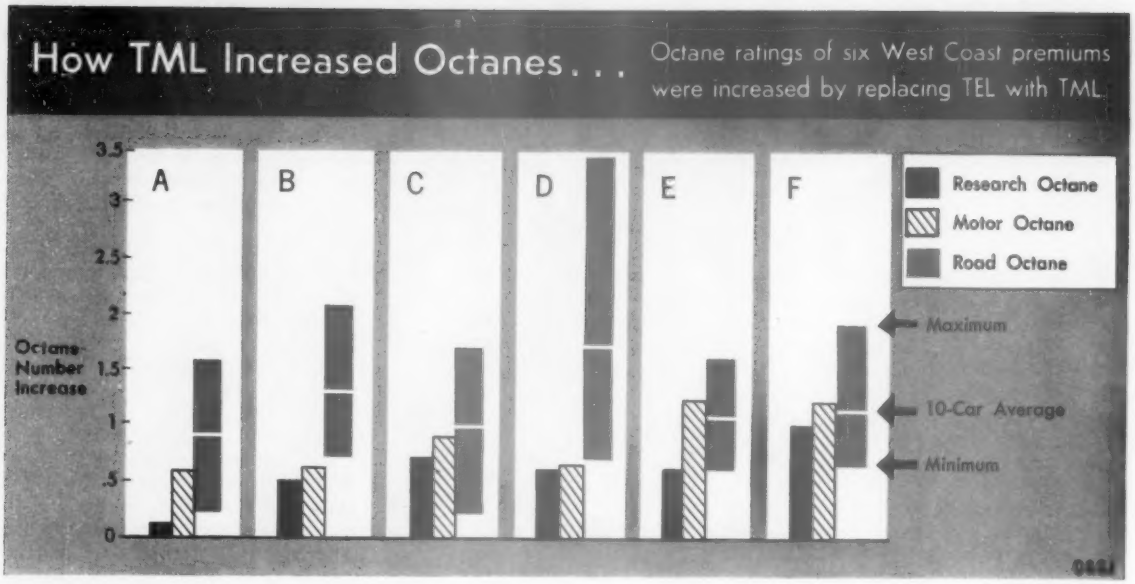
The company reportedly spent more than $9 million on its 3-year study of shale oil processing.

Test results . . . While in operation the plant extracted as much as 26 gal. of oil from a ton of shale. The facility produced from 600 to 800 bbl. of raw shale oil daily from a 1,200-ton retort. The output varied with the quality of the shale ore.

The raw shale oil is a waxy product not suitable for pipeline movement. However, after distillation, coking, and treating with Union's Unifining process, the oil produces a 40° fuel oil which can be processed into a wide range of products.

About a year ago the company said retorting costs had been cut to considerably less than $1 a barrel, and an executive said Union was aiming at a cost of 50 cents per barrel.

It has been estimated that there are 1.5 trillion barrels of shale oil in a 1,200-sq.-mile area just east of Rifle in the Piceance Creek basin.



SOCAL Jilts Ethyl for Methyl

• Standard of California is switching to TML from TEL in premium gasoline from coast to coast. The company says it can get more octanes at a lower cost by using different antiknock compound.

David H. Stormont
Refining Editor

THE STANDARD Oil Co. of California companies last week became the first to offer American motorists "Methyl" motor fuels.

In premium gasolines of Western Operations, Inc., Standard Oil Co. of Texas, The California Co., Salt Lake Refining Co., and California Oil Co., tetramethyl lead has completely replaced tetraethyl lead. In the regular and super-premium fuels, both TML and TEL are used.

Before offering the new gasolines, California Standard tested the new antiknock compound in more than 2.5 million miles of road service. It also contracted for the entire current TML output of both the Ethyl Corp. and Du Pont. Use patents have been granted in some European countries and have been applied for in this country.

Why the switch . . . Standard said it is switching to TML because it is a more effective antiknock agent for today's gasolines.

Over the years the composition of gasolines has changed so that TML is a more effective knock suppressant than it was when first seriously investigated about 25 years ago. The high compression ratio of todays' cars causes TEL to break down too early to give maximum effectiveness, California Standard researchers found.

The change to gasolines having an aromatic content in the range of 30% and higher particularly favors the use of TML. Catalytically reformed stocks, which are the heart of most modern, high-octane gasolines, also respond better to TML.

In conducting the 10-year research project, California Research Corp., a California Standard subsidiary, studied the preflame reactions of hydrocarbons which cause engine knock, and the mechanism by which antidetonants suppress knock. In shock-tube studies designed to measure thermal stabilities of anti-knock compounds, they found TML to be more effective in suppressing preflame reactions.

A void octane increase in the order of 1 to 2 numbers can be expected for most cars when TML is used in place of TEL in premium gasolines, the company found. The gain varies from car to car, as the chart above shows, but TML always is more effective than TEL in their commercial premium fuels.

The octane information was obtained by tests conducted with 10 late-model cars in Cal Research's fleet. The six test fuels were commercial motor fuels in the 98 to 102 Research octane range. Their aromatic content ranged from 20 to 45%. Substitution of TML resulted in a road-octane number increase of 3.5 in one particular car.

No health problem . . . Substitution of TML for TEL introduces no health problem, Cal Research found after conducting a several months' test. The U. S. Surgeon General has concurred in this finding, according to J. R. MacGregor, Cal Research vice president.

MacGregor also said the substitution of Methyl fluid for Ethyl has been cleared with both Ethyl Corp. and Du Pont, and the necessary state and federal agencies having to do with product labeling. Although some TML may be contained in the gasoline from pumps carrying the "Ethyl" label, the substitution is legally acceptable since no dilution or misrepresentation are involved.

Cost . . . Initial cost of TML to the refiner will be considerably higher, on a contained lead basis, MacGregor said.

Ultimately the cost will be only

slightly higher. At its current price TML can provide a road-octane improvement considerably cheaper than can be obtained through extra processing, he added. After new plant capacity has been added by Ethyl and Du Pont, TML will become available to other refiners.

The California Standard companies will not up the octane of their motor fuels, MacGregor said—"we are not going to touch off another octane race." Although it ultimately may be used in their aviation gasolines, initially TML will be used only by California Standard in motor fuels.

Success of a California Oil Co. advertising program at the time it switched over from the "Calco" to the "Chevron" brand, caused California Standard to use a similar teaser technique. A couple of weeks prior to the introduction of "Methyl" gasoline, all billboards and other advertising media sported only a big "M." Last week the signs were switched over to "Methyl, First new antiknock compound since Ethyl."

Old Law Upheld

. . . by Pennsylvania court.

State wins oil-gas rights.

PENNSYLVANIA'S peculiar law on the conveying or reserving of oil and gas rights has been upheld by the State Supreme Court. As a result Pennsylvania is immediately richer by more than $1,000,000 and expects to pick up a lot more cash in time.

In all other states, mineral rights include gas and oil. In Pennsylvania when mineral rights are conveyed or reserved they do not cover oil and gas unless they are specifically mentioned.

The now-defunct Penfield Coal & Coke Co., owned the mineral rights to 3,784 acres of state forest lands in Clearfield County. Three years ago the county's Common Pleas Court ruled that this gave the company ownership of gas on the property. The state contested the decision.

The case was appealed to the state supreme court. It ruled 5 to 1 that the gas is the property of the state. An immediate result will be to turn over to the state $1,167,678 which New York State Natural Gas Co. has paid for the gas and which has been held in escrow.

The decision also cleared the way for opening other state forest tract areas to oil and gas operators. These tracts cover extensive areas in the north central Pennsylvania gas area.

The law, which the court upheld has been on the books since 1880.

watching WASHINGTON

Clyde La Motte

• The log jam at the FPC . . .

THE PROBLEM of speeding up procedures at the Federal Power Commission got another airing in Washington the other day.

The setting was a meeting of the Federal Power Bar Association at which a three-man panel discussed possible ways of breaking the ever-growing log jam of cases that keeps piling up at the FPC.

The three experts were William Tarver, counsel for Southern Natural Gas Co.; Ralph Zwerdling, an FPC examiner; and Luke Lamb, a senior attorney in FPC's office of general counsel.

The three were in unanimous agreement on one point: Something has to be done, else everyone concerned—including the eventual consumer—will suffer.

Beyond that point, however, there wasn't too much meeting of the minds.

From Tarver's viewpoint, the thing to do is simply to eliminate the full field investigation the staff does in virtually all cases.

Tarver pointed out that the field investigation is the chief cause for the interminable delays. The purpose of these field studies, of course, is to give the staff an opportunity to study a company's books to obtain data upon which the staff's recommendations can be based.

But, as Tarver sees it, a much more efficient and faster way would simply be to require a company to submit all necessary data under oath.

The FPC staff could then study this information without time-consuming field studies. And if it felt the information was insufficient on any given point, it could direct the company to supply that, too.

Admittedly, this would put the burden of work on the company rather than on the FPC staff. But Tarver figures the companies would come out ahead in time and money saved.

• What about interim reports . . .

THE INTERIM-ORDER procedure as a possible way of speeding up case handling came in for considerable discussion by the panel. And each of the panel members had a different view.

Tarver made it clear he doesn't think much of it. He considers this a piecemeal approach which would tend to lengthen rather than shorten the disposition of the over-all case. Furthermore, he doesn't think one issue can be settled properly unless considered in context with other issues of a case. Put bluntly, he feels, the interim-order approach is impractical—and perhaps illegal.

Zwerdling defended the interim-order procedure only as one possible tool for prying cases free of the log jam.

He urged, instead, that the companies, the FPC staff, and the hearing examiners try to work together to cut through legalistic red tape and get to the heart of the key issues of a case promptly.

He didn't agree with Tarver's suggestion that the field studies be eliminated entirely, but he did indicate that they can be shortened greatly by a common sense approach to a case.

Lamb defended the interim-rate procedure and made it clear that, unlike Zwerdling, he felt little real progress could be made in a case until a full-scale field study had been made.

During an intermission, someone suggested that Tommy Corcoran be called in to see if he had any suggestions for getting prompt action at the FPC.

Banker Sees Rosy 5-Year Oil Demand

• New Yorker predicts world surplus will be corrected. He also sees a fierce fight for markets rising from the North African production.

CONTINUED demand growth over the next 5 years will mop up all the present world-wide surplus of petroleum capacity.

And during the second half of this decade, talk of an oil and gas shortage should not sound quite so much out of place as it does today.

These glimpses into oil's outlook in the next 10 years were given last week by Edward Symonds, petroleum economist for the First National City Bank of New York. He addressed the Fort Worth Petroleum Club.

Symonds gave this 5-year demand outlook: An expected increase in demand averaging 5% annually. This will mean an increase of 6,000,000 bbl. daily by 1965.

Presuming only a modest increase in capacity during the same period, the demand rate would be sufficient nearly to correct the present surplus. The rosy demand outlook is based on continued heavy consumption in the U. S. stemming from population growth and new technological breakthroughs. Abroad, economic transformations will gather speed in Europe, and new oil markets will be born in Latin America, Asia, and Africa.

Unless the civilized world pulverizes itself into oblivion, Symonds predicted "this new demand will develop—part of it in our lifetime.

"The volumes concerned are still small. But governments, people, and companies are at least united in one thing—their determination to make them grow."

Some tough years . . . The oil industry has had some tough years and will have a few more of the same before a demand-supply balance is near, Symonds warned.

He pointed out an analysis of more than 130 oil-company reports showed 1959 net earnings at only 10% of capital invested compared with some 15% a decade before. The greater profit ratio was made back at a time when the domestic industry was unprotected except for a tariff of 10.5 cents a barrel.

The changed profit climate is only one domestic aspect of the current period of world-wide oil surplus. Another is the entire import-control system with its exemptions of Canadian and Mexican crude, its profits on crude exchanges, and artificially low

Edward Symonds
. . . a few tough years to weather.

import quotas for many oil companies.

One almost overlooked result of the import controls is the practical advent of administered oil prices. This was apparent when the domestic price level was immediately brought into question last fall during talk of an impending residual shortage and a move to relax controls on this product. The incident demonstrated that through its freedom to vary the rate of imports, the Government now has a price-control tool.

Foreign developments, thus, remain important to every aspect of the domestic scene.

Trouble abroad . . . Foreign exploration has been too successful too soon.

Symonds reported the postwar fears of oil shortages now seem to belong to another age—or another planet. In the last 10 years discoveries in the Middle East and now North Africa have raised proved reserves outside North America nearly fivefold and probable reserves by much more.

Symonds estimated that although production based on foreign reserves has risen more than threefold, a total of from 3,000,000 to 4,000,000 bbl. a day of shut-in capacity exists in Canada, the Middle East, North Africa, and Venezuela.

The result, Symonds said, is that international companies have cut down on their foreign drilling. Many estimate that pools already developed are large enough to meet a substantial jump in demand without further capital spending. In fact, the rush into foreign operations showed signs of slowing up in 1959 with profit margins falling and a general disappointment with foreign business.

The extent of new finds has been such that the main bastions of foreign oil supply—the Middle East and Venezuela—are now under serious attack, Symonds declared.

The immense new reserves of the Sahara have eased the shortage fears of European consumers but they offer new perils to the companies marketing in Europe and the Middle East producers.

The French Government has made it clear the French market must be switched to Algerian production in the next 3 or 4 years and is trying to win preferential treatment for Algerian oil in the common-market nations.

A slowing down in the rate of growth of Middle East production is inevitable, Symonds said, pointing out this may not be so smooth as it sounds. It will take some persistence for oil companies to persuade the Middle East rulers that present oil income of about $1.3 billion a year may be near its peak and that further growth cannot be bought at the price of dumping on a surfeited market.

Venezuela also faces big new problems over the next few years. Symonds said Venezuelan goverment tax action in 1958 of altering the 50-50 profit split to a 60-40 principle simply reduced the attractiveness of Venezuelan reserves. Drilling activity has fallen to under one-half of its earlier rate, and a new 3-year labor contract signed in February doesn't help matters by adding $100 million a year to industry costs.

Symonds said Venezuela's chances of capturing new markets in Europe are slim. The American market is curtailed by import controls. The Canadian market, now about 200,000 bbl. daily from Venezuela, is under attack from Canadian producers. And other Latin American consuming countries are actively promoting exploration programs of their own.

Market struggle . . . The economist commented the supply picture seems

to indicate the stage is set for a lethal fight for markets abroad.

He warned, however, that in such a struggle the domestic American producer would get hurt—and hurt much more than by the recent nibbling at domestic crude prices.

There are built-in reasons against excessive price cutting, Symonds noted. The first is knowledge that a cut in price will not bring a worthwhile increase in volume. Any major price cut abroad is likely to be quickly matched by the competition. Also, the governments may sop it up in the form of higher excise taxes.

The price and market structure abroad may increasingly come to depend on intercompany exchanges and purchases by established marketers of other-company crude, Symonds said.

This also creates a dangerous situation. It makes the possibility of "distress" sales more acute. But fortunately, almost all of the surplus crude overhanging the world market is in the hands of financially strong, mainly American companies who can avoid dumping practices.

The growing shadow of Russia also is becoming a factor in this precarious crude market. Russian crude has recently entered the world market at around $1 per barrel, f.o.b. Batum. The Soviet politicians easily could decide to sell all their exports at prices it would pay no one to match. In their foreign dealings so far, however, the Russians have shown up as hard bargainers who like haggling to get the most needed foreign exchange.

Symonds said the chances seem to be against a general attack on world crude prices although individual oil markets will continue to be undercut for local political advantage.

He added that in the years ahead political dangers from "national" oil in "captive" markets may be more worrisome than the economic dangers arising from oversupply.

Independents' Goal: Sharp Imports Cut

• Independent producers are convinced additional restrictions on imports of foreign oil are needed to help the industry weather the tough times. However, there was some disagreement on just how to go about it.

THE NATION'S independent oil producers teamed up last week for a new assault on the imports program.

There was quite a split among them on how they should go about it. But they were unanimous in one opinion: The present economic plight of the producing industry demands a further restriction on imported oil.

The decision was reached in Denver by a liaison committee representing 14 state and local oil and gas associations. It was announced despite indications from Washington that the Government is pretty well pleased with the program and despite a warning from Capt. M. V. Carson, imports administrator, that producers should look elsewhere for a solution to their problems.

Carson told the midyear meeting of the Independent Petroleum Association of America in Denver that the program is working well, that it was not designed to cure all of the producers' ills, and that the real culprits in their economic plight are natural gas, coal, refiners who weakened markets by making too much product, and state regulatory officials.

Independents' view . . . The oil men agreed, but only partially.

The imports program, they contend, was designed to guarantee national security by guaranteeing a healthy domestic industry.

The industry at present is sick, they say, because of several problems:

. . . The shift in refinery yields has been such that increased demand for all products except residual is being met without an increase in crude-oil production. Producers are not sharing in the bigger market and, in effect, are being penalized by constant addition of new wells with which they must share their allowables.

. . . Price cuts and pipeline proration, together with choked-down allowables, have made the plight of many producers critical.

. . . Because of government and industry estimates, the industry geared up for an annual increase in demand of 5%. This has failed to materialize, and the industry has a surplus capacity which threatens stability.

Too, they say, the President's proclamation setting up mandatory controls provided that the Government should keep an eye on prices. This presumably was to protect the consumers against price increases, but the producers wonder if it doesn't work both ways. Shouldn't the Government be concerned about an oil industry weakened by price cuts?

The conflict . . . All independent groups apparently were in agreement that a further cut in imports is needed.

But they were far apart on how the problem should be handled.

Most of the smaller groups, together with the Texas Independent Producers and Royalty Owners Association, felt that an aggressive and immediate effort should be made.

The IPAA felt that, while the ultimate goal is important, it would be foolish to complain loudly to Washington now. This, they felt, might serve only to organize opposition to the effort and antagonize import and State Department officials.

The statement issued by the liaison committee indicated several associations will join TIPRO in presenting its case to the Secretary of the Interior in Washington May 10.

The IPAA indicated it will not be represented in the group.

It adopted a resolution in its midyear meeting calling for a further reduction in imports and asking that Canadian crude and products be counted against import quotas.

Independents felt generally that residual fuel should be counted as crude oil and charged against quotas, but a proposal to this effect was deleted from the resolution.

Carson's views . . . The imports administrator, addressing the IPAA, was critical of the TIPRO plan to confer with Seaton.

"I would suggest," he told the IPAA, "that the federal Government has firmly and courageously tackled the import situation."

The real problems, he suggested, lie elsewhere—with gas and coal producers "who together influence the energy supply far more than does imported oil," with state officials, with jobbers and marketers "who indulge in wasteful marketing policies," and with the refiners "who produce more products than can profitably be sold."

"Playing water on the tool shed while the main house burns to the ground doesn't make much sense to me, especially if the tool shed already has been fireproofed."

Offshore Payout Still Years Away

• Continental's Ira Cram hints offshore companies should be operating in the black soon, but recovering total outlay is still well in the future. CATC alone has run up a deficit of $217 million in 14 years' operations.

FOURTEEN years have passed since the oil industry began searching in earnest for oil in the waters off Louisiana. Despite the phenomenal success of that search, the industry is still 1.87 billion dollars in the red.

Even this dismal figure is misleading. The debits do not include administrative, overhead, and operating expenses—just the direct investment, minus the revenue.

There are signs that the time of writing with red ink is nearing an end. But, even when it comes, the day that the total investment is recovered lies years in the future.

This roundup of the oil industry's costly experience in offshore Louisiana has been prepared by a man who was there almost from the beginning—a man who sweated through the problems produced by overwater drilling, by federal and state regulation, by oversupply and high costs, by wind, wave, and Washington.

This offshore pioneer is Ira H. Cram, senior vice president of Continental Oil Co. and a force in the offshore movement from its early days. It was back in 1946 that Continental joined with Atlantic Refining, Tidewater, and Cities Service to form CATC with Continental as operator.

Testifying recently before the Federal Power Commission in a CATC rate case, Cram told the Louisiana offshore story with fact and figure.

In running up a deficit of $1,869,000,000 off Louisiana, Cram said the industry has drilled 2,843 wells and produced 258.9 million barrels of oil and condensate. Gas production as of October 31, 1959, totaled 842.4 million M.c.f.

At the close of 1959, the industry had paid $477,155,000 in bonus money for 3,357,117 acres in offshore tracts. The average cost per acre has been $142.

The obstacles . . . Why has there been the great lag in revenues in an area so prolific?

Cram cited three general classes of obstacles which have plagued the offshore operator from the beginning—those man-made, those of Mother Nature, and those economic, all interrelated.

The man-made obstacles mostly can be laid at the doors of the U. S. Government and the State of Louisiana, the battling claimants to much of the offshore territory. The war actually started in California with a federal lawsuit in 1945 but erupted in earnest in 1948 when the U. S. Attorney General went to the Supreme Court to establish federal rights in the Gulf of Mexico.

The action slowed development for several years and placed in jeopardy the industry's investment. Not until passage of two federal acts in 1953 was the atmosphere temporarily clarified, and it wasn't until 1956 that the federal and state governments reached a satisfactory leasing agreement pending outcome of the tidelands ownership case, which is still in the court.

To complicate further this activity, the Supreme Court handed down the Phillips case decision in 1954 and slowed down operations on gas properties.

Mother Nature . . . Working offshore is costly.

Operations are far more expensive than those onshore. High seas cause costly shutdown time, and reservoirs cannot be developed as quickly because of limitations of the drilling platforms and barges.

Fighting fires is harder over water—and the CATC group knows this

from experience. A platform fire in 1958 cost the group millions.

"The challenge of high costs peculiar to offshore operations is the single greatest offshore problem today," Cram said. Tremendous efforts are under way to accomplish this task—but there is still much to do.

Economic obstacles . . . The impact of economics on offshore operations cannot be calculated yet. But it is formidable.

An operator who has the good fortune to find gas, for example, cannot expect to start collecting revenue for the first 3 to 5 years.

"A big costly reserve of oil and gas means little if you can't sell the reserve at a reasonably fast rate even when the price is reasonable."

The world's oversupply of crude and the low well allowables have created this very uncertainty.

Although Louisiana has established a differential in favor of offshore wells—1½ times the onshore allowable—the allowables today are only about 35% what they were when offshore operations began in earnest.

The success ratio . . . Operators have been willing to pay the high costs offshore because 35.3% of the wildcats off Louisiana have been successful. This compares with a success ratio of only 11% for all domestic wildcats.

Also, 72% of all Louisiana offshore wells have been completed successfully.

But Cram added a word of caution. Eventually there will be a sharp decline in the success ratio after the better structures are drilled.

"Offshore the little field is as calamitous as a dry hole and acts as a preventive in the discovery of the big field through dissipation of financial reserves," according to Cram. "The offshore operator must look to the big fields for his profits, and they must bear the expense of both dry holes and little fields."

What about CATC? . . . CATC's outlay from 1946 to the close of 1959 has amounted to $284,785,000.

The revenue? $67,492,000. The deficit: $217,293,000.

"This looks bad, and it is bad," said Cram. "Fourteen years of effort and out-of-pocket expense and still that far behind the eight ball. Each and every one of those 14 years we have spent more than we have received."

Is there a silver lining?

"In 1959 we actually operated in the black for some months, but not for the year as a whole. We trust that we can shift into the black and stay there, but even if we do we will be a long time reaching the point where we have received revenues fully repaying our outlay."

The future . . . The big gap between outlay and income raises the obvious question: Has the entire CATC offshore operation been ill-advised from the beginning?

Cram says no.

"I am saying that it could be a lot better," he said. "We have found some big fields. We also have found some dusters and some cats and dogs. We can thrive only on the big and giant fields which must not only pick up the tab for the dry and small fields but generate large sums for continued exploration and development."

Low prices will be reflected in a slowdown offshore, he said. While the giant fields would not shut down, small reservoirs would be abandoned and further exploration would be discouraged. With a large cut in the price of gas, exploration in some gas provinces offshore would end.

Cram summed it up: "There must be a sufficient price to justify the enormous risks we have taken in going into the offshore operations, and to encourage us to continue offshore operations designed to replace present and add new reserves in pace with rising demand in this costly but prospective area."

Cost of a Fire

WHAT did the CATC platform fire of 1958 really cost?

Continental's Ira Cram disclosed to the FPC some revealing figures on the disaster that took six lives when an explosion occurred on the five-well platform off Louisiana.

Here they are:

- **$2,380,000** to put out the fire and bring the wells under control.
- **$1,270,000** damage to the platform.
- **$2,800,000** spent so far to restore production.
- **The total—$6,450,000.** This does not include undetermined damage to the reservoir.

Insurance recovery came to $2,311,000. Net loss on the items listed—$4,139,000. Another item yet to be met is the loss resulting from personal injuries. CATC companies have more than $2 million in lawsuits pending against them.

Other companies also suffered losses. Nicklos Drilling Co.'s rig, valued at perhaps $800,000, was destroyed.

Texaco Has Good Showing for First Quarter

TEXACO INC. came "home" to Houston last week, after an absence of 33 years, to report to the annual stockholders meeting a glowing performance for the year 1959, record earnings for the first quarter of 1960, and a healthy outlook for the decade ahead.

Houston also learned that some 260 employes and officials in the manufacturing and engineering departments are now in the process of moving from New York to Houston, where a new building has been completed.

Headquarters for virtually all domestic operations, except for marketing, are now located in Houston.

Board Chairman Augustus C. Long said the company has made no decision yet on whether to move marketing headquarters to Houston from New York.

At the meeting, Long reported net income of $354.3 million for 1959, an increase of 13.9% over 1958, and the highest in history. For the first quarter of 1960, the records were broken again. Net income came to $97.3 million, highest in any quarter yet.

After the meeting, Long said the day of holding stockholder meetings in New York is ended. Following a trend now developing in industry, Texaco will go to other cities for the annual affair.

Long also commented on other Texaco activities:

. . . The company favors a tariff in preference to the mandatory import control program, but does not want the U. S. "flooded" with foreign oil.

. . . Texaco is still stymied in its efforts to bring about a merger with Superior Oil Co. because of the Justice Department's contention that it would violate the antitrust laws. There are no new negotiations but "nothing is ever dead."

. . . There is no danger that Russia will "break" the world price of crude in the foreseeable future (see Foreign News). Russia doesn't have enough crude to export.

. . . Texaco has made a financial arrangement with the Cuban government on the operation of its Santiago refinery. The arrangement concerns an exchange in dollars and pesos which Texaco hopes will "work to our mutual satisfaction."

IPAA's Supply-Demand Forecast for 1960

(Includes Alaska and Hawaii)
All figures except closing stocks in thousands of barrels daily

	Actual 1959	1st Quarter 1960*	2nd Quarter 1960	3rd Quarter 1960	4th Quarter 1960	Year 1960
Domestic Demand						
Gasoline	4,066	3,717	4,390	4,460	4,135	4,175
Kerosine	301	493	170	200	395	315
Distillate	1,809	2,692	1,360	1,210	2,175	1,860
Residual	1,547	1,955	1,365	1,250	1,630	1,550
Other	1,728	1,667	1,780	1,995	1,855	1,825
TOTAL	9,451	10,524	9,065	9,115	10,190	9,725
Exports						
Gasoline	45	30	45	42	42	40
Kerosine	3	3	2	2	2	2
Distillate	34	30	35	35	35	34
Residual	56	56	45	45	45	48
Other	73	78	76	76	76	76
TOTAL	211	197	203	200	200	200
Total Demand (including Exports)	9,662	10,721	9,268	9,315	10,390	9,925
Total Stock Change	+51	−683	+166	+135	−257	−161
New Supply Required	9,713	10,038	9,434	9,450	10,133	9,764
Closing Stocks (Million Bbls.)						
Gasoline	187.6	225.7	194.1	162.4	173.4	173.4
Kerosine	27.7	17.6	25.1	32.3	28.0	28.0
Distillate	151.2	75.5	110.8	147.9	123.2	123.2
Residual	53.5	39.2	36.4	42.5	41.1	41.1
Other Products and Natural Gas Liquids	131.9	130.0	139.2	134.3	130.1	130.1
Crude	257.1	259.0	256.5	255.2	255.2	255.2
TOTAL	809.0	747.0	762.1	774.6	751.0	751.0
Runs to Stills	7,994	8,075	7,886	7,808	8,258	8,007

*Estimate based on U. S. Bureau of Mines and API figures. Source: IPAA.

IPAA Trims Forecast

. . . of U. S. demand for 1960. It now sees gain of 247,000 bbl. daily or 2.9%—well below business in general.

OIL'S OUTLOOK for 1960 isn't quite so optimistic as it was last October.

Demand will be up, but it won't rise as much as expected.

That was the conclusion last week of the supply-demand committee of the Independent Petroleum Association of America.

The committee, headed by Ohio Oil Co.'s N. G. Dumbros, forecast an increase of 2.9% or 274,000 bbl. daily this year. This is roughly 100,000 bbl. daily under the committee's annual forecast made last October.

The changed forecast was not due to pessimism over the general business outlook. The committee still sees a growth in the national economy of about 6% this year, with Gross National Product rising from $479 billion to $508 billion and the FRB index climbing from 105 to 112.

Oil's 1960 outlook was dimmed, the committee said, by a poor fourth quarter last year and the fact that demand did not bounce back sharply in the first quarter this year.

No more crude . . . The committee also concluded that the increase in demand can be met with practically no increase in crude-oil production in this country this year.

But it pointed out quickly that this conclusion is based on a change in the association's method of forecasting.

In the past the committee has forecast changes in stocks. This year it based its supply-demand forecast on inventory levels which the industry told the Texas Railroad Commission would be adequate.

On this basis, the committee concluded that there would be a reduction in total inventories averaging 161,000 bbl. daily. By contrast, inventories in 1959 rose at a rate of 51,000 bbl. daily.

On this basis, the committee said, crude-oil production this year in the U. S. need average only 7,060,000 bbl. daily, up only 6,000 bbl. daily over a year ago.

If the industry should fail to reduce inventories sharply, however, crude-oil production would be increased.

Members felt there is little likelihood stocks will be reduced anywhere near the "recommended level," and that crude-oil production will, therefore, be higher than the level shown in the forecast.

The committee predicted a continuing decline in exports, setting them at 200,000 bbl. daily in 1960, down 14,000 bbl. from its October forecast and down 11,000 bbl. from actual 1959 figures.

It set imports this year at a level of about 1,797,000 bbl. daily, up 20,000 bbl. from last year.

Producing Capacity

. . . increases with excess climbing to 2.5 million barrels daily, IPAA says.

DESPITE a lower rate of activity last year, the nation continued to add to its surplus producing capacity.

On January 1, the U. S. had an unused capacity of 2,501,000 bbl. daily of crude oil and gas liquids. This represents 23.4% of the nation's total productive capacity of 10,675,000 bbl. daily.

These are the conclusions of the productive-capacity committee of the IPAA presented to the association last week at its midyear meeting in Denver.

The committee said that 89,000 bbl. daily of extra capacity was added in 1959. Of this amount, 52,000 was in crude oil, and this compares with additions of 163,000 bbl. in 1958 and 243,000 bbl. in 1957. The slower rate of growth, the committee said, reflects a decline in drilling activity.

While the group makes no study of transportation facilities to determine how much of the surplus could be moved quickly in an emergency, it says the figures provide "a reliable indication of the current availability of crude oil and natural-gas liquids."

Dealers Say TBA Items Not Forced on Them

• Testimony made before Roosevelt's subcommittee clears companies of charges made at hearing last December.

MAJOR OIL companies paraded facts and figures before a congressional subcommittee in Washington last week in an effort to refute charges that they had coerced their service-station dealers into selling only the brands of tires, batteries, and accessories sponsored by them.

The hearing was the second of two hearings held on the issue by a House small-business subcommittee, headed by Rep. James Roosevelt (D.-Calif.). The first was held last fall.

For the most part, the companies rested their defense on affidavits from service-station operators who had been cited in an earlier hearing last December as examples of dealers who had been "coerced."

In virtually every instance, these affidavits completely contradicted the claims—made by others—that these dealers had been pressured or threatened by their oil suppliers.

The gist of these affidavits was that while the major from which they were leasing a station had tried to sell them particular brands of TBA merchandise, they had not been forced to buy them. Instead, many of the dealers said, they had continued to stock and display other brands as they saw fit.

Many of the affidavits cited figures to show that they were still buying merchandise from independent TBA wholesalers and others. In some cases, such purchases were increasing.

Dealers appear . . . Here are some of the examples of the conflict between the evidence submitted by the oil companies last week and the charges made last December before the same subcommittee:

It was charged last fall that an independent wholesaler had been unable to sell a certain service station Prestone antifreeze because the oil company supplying that station (Pure Oil Co.) insisted that the operator sell only the Pure brand of antifreeze.

H. L. Moir, vice president of marketing for Pure, told the subcommittee last week that this charge was ridiculous because Pure itself sells Prestone in addition to its own brand.

In another instance, it was claimed last December that when Pure put on a Christmas tree ornament promotion, a certain service station refused to participate and that the operator's lease was subsequently canceled.

Moir testified that the dealer in question still has his lease.

Perhaps the most effective rebuttal of all involved W. L. (Bill) Schmieding, operator of a Continental Oil Co. station at Lincoln, Neb.

Victor L. Toft, president of the Automotive Service Industry Association, had dwelt at length last December on Schmieding's case.

In his testimony, Toft had said that Schmieding had once handled Sieberling tires and had had good success with them but that he had been "forced" by Conoco to quit selling them.

According to Toft, Schmieding finally rented a building next door so he could stock Sieberling tires there.

But Schmieding testified last week that this was absolutely not true.

He said he had continued to stock and sell Sieberling tires and that he was still continuing to do so. Conoco had not tried to force him to stop, he said.

As for the renting of the building next door, he said he did that simply because his station was small and didn't provide any storage room.

Schmieding said he did not know Toft and that Toft had never contacted him before or after he (Toft) testified last December.

In addition to the testimony given by Pure Oil Co. and Continental Oil Co., representatives of Richfield Oil Corp., Mobil Oil Co., and Gulf Oil Corp. also were heard.

This will apparently wind up the hearings, although further effort may be made by the subcommittee to pin down the discrepancies in the stories told last December and the testimony presented last week.

There were hints by subcommittee members that someone might be held in contempt of Congress if it turned out that statements made to the subcommittee were incorrect.

In this connection, it appeared clear that the subcommittee members were impressed by the affidavits produced by the oil companies.

Green River Bid Denied

THE Federal Power Commission last week threw out an "informal protest" against plans for a natural-gas pipeline serving the Green River basin of Wyoming.

Green River Basin Corp., Chicago, asked FPC to consider the entire basin as a unit and to give gas producers there a chance to share in any pipeline system which would be necessary to move the gas.

Robert V. New, president of the firm, told FPC reserves in the area should not be piecemealed out to existing gas-transmission companies.

The protest was in connection with an application the commission is now considering from El Paso Natural Gas Co. and Colorado Interstate Gas Co. Their application is known as the Rock Springs project.

New told FPC that pipeline competition will be needed in the area, that if El Paso were the only purchaser producers would not have a strong bargaining position. Because of high costs, he said, producers will be at a disadvantage unless they can share in profits of transporting the gas.

It didn't take FPC long to act on New's request. Shortly after he filed his statement, FPC notified him it could not be considered because Green River Basin Corp. is not an intervenor. The hearings in this case have been completed and, regardless of the merits of his petition, it could not be considered.

New's petition was based on his contention that the area will develop into one of the nation's major sources of natural gas. The area, he told FPC, has reserves of probably 45 trillion cubic feet.

Proved reserves of the basin have been estimated by others at about 6 trillion cubic feet. Most of this gas has been dedicated to El Paso Natural, which has a line through the basin from Pinedale and Big Pine fields.

One reason for his petition, he said, was the hope of delaying action so that he might have time to develop plans for a pipeline.

Three wells have been drilled on units in which New's company holds an interest.

None of the wells is currently producing. One is plugged after a serious casing collapse. A second blew out and burned but has been capped and will be completed. The third is waiting new financial arrangements by the operator before it can be completed.

HISTORY of U. S. political parties is outlined at Conoco workshop by Andy McColpin, Conoco attorney. Seated at speaker's table are W. O. Ham, Jr., left and Will Rounds, workshop moderator.

Conoco's Political Workshops Pay Off

• The nonpartisan sessions are popular at all employe levels. One result is increased political activity. Another is a better company team spirit.

RECENTLY, the industrial-relations head at Fort Worth for Continental Oil Co.'s Southwestern region received a letter from one of its union production employes in Forsan field, Howard County, Texas.

The writer asker Conoco's Dee Devaney if it would be possible for management to hold one of its "Political Workshops" in nearby Big Spring for the Forsan production employes.

A couple of the Forsan workers, he advised, had attended an earlier workshop. They praised the program highly and aroused the interest of other employes. The whole Forsan field staff held a meeting on the subject, he said. And they had worked out a plan whereby they could attend a 2-day Big Spring program and still not miss a barrel of production.

They would get up early, do the required work, drive to Big Spring in time for the workshop, and finish up their regular work on returning to the field at night.

Management quickly accepted the invitation.

This, says Conoco's regional general manager at Fort Worth, W. O. Ham, Jr., has been typical of the reaction of employes generally to the political workshop—a new idea in the field of corporate political activity.

A nonpartisan approach . . . The program was started by the southwestern region under Jerry Pearson, former manager, and enthusiastically continued under Ham.

The region already has held eight workshops. It is now holding about one a month. Hopes are to boost the total to 20 by a year from now. So far, 408 Conoco employes have attended.

The program has been so successful that other Conoco regions have sent observers and started similar programs of their own. The company's Central region now has held three. The Rockies region recently staged its first workshop. The Northern region and the pipeline department are in process of starting up.

The Conoco workshop is completely nonpartisan. The company doesn't care whether the participants are Democrats or Republicans, conservatives or liberals. Workshop moderators carefully steer discussion away from controversy.

Conoco, Ham says, aims at accomplishing only two things with its workshops. These are to:

. . . Create an awareness in the employe of "the obligations and responsibilities we have as citizens."

. . . Stimulate him into action—into "accepting his responsibility so as to preserve our democratic form of government." By this, Conoco doesn't mean just nudging the employe to appreciate and use wisely his right to vote. This is a big part of it. But it also encourages him to attend party conventions at the precinct level and higher, to serve as a delegate, and even to run for office.

Grassroots politics . . . Conoco has found that most people are appallingly lacking in even the most basic knowledge of politics and democratic processes. And it seems to make little difference whether the man is an executive or a field hand.

Few have ever attended a party precinct convention. Few know their precinct or area number or precinct chairman. Very few vote in all elections. Hardly any know the names of their state representative and senator.

Few have ever written these public officials.

The company's political workshops are aimed at puncturing this lethargy.

The real meat of the course is a panel presentation on precinct politicking.

The moderator, in a question-answer session with one or more precinct chairmen, brings out: Why and when precinct conventions are held; how you can attend; how they are run; how a small minority of voters in a precinct can control it by controlling the convention; and many other facets of precinct politics.

State legislators are present for similar session on state government. Along with how the state government operates, the participants get direct practical advice on how, what, and where to write a legislator. Answers are given to such questions as: What does a state representative do? Is he more apt to heed a letter or is a phone call or wire better?

In other sessions, there are discussions on the poll tax, political fallacies, selection of candidates for office, issues, and politics on the national level.

The response . . . The only benefit to the company that Conoco could see when it started the workshops was that it should gain indirectly from anything which helped make better citizens of its employes.

The gain might be a bit nebulous. But the company felt the program worth the time and expense, anyhow.

The resulting employe enthusiasm proved the point.

Conoco's Wichita Falls refinery employes — following the workshop there—chalked up a 93% total poll tax payment—and this included wives and husbands of plant employes.

Devaney, Conoco's regional head of industrial relations at Fort Worth, says: "A great many of our employes are getting on a first-name basis with their state senators and representatives. They know who to write and do it when they are for or against something."

Employe participation in precinct and county level politics has increased noticeably.

At first, Devaney says, there was some skepticism among employes attending workshops as to the company's intentions. "They came fully expecting to get pressured to join a 'Young Republicans for Nixon' or 'We Like Lyndon Johnson' club." A union official admitted frankly that he came "to do battle." But the skepticism melted away when employes learned that the workshops were not slanted.

A morale booster . . . Post-workshop comments and letters disclosed that the company is making progress in another direction.

Will Rounds
. . . Workshop moderator.

The workshops are serving as an important tool to improve communication between management and the man in the field or plant.

Pumpers and plant workers rub elbows, chat, and drink coffee at the workshops with vice presidents and managers.

A refinery worker and union member wrote following a workshop to say: "I had about become convinced that management didn't give a damn. Now I know that isn't so."

A production field hand commented that he now could see for the first time that "what is good for Continental is good for me."

The workshops, Conoco feels, have helped knit the company people closer together. And this is a tremendous plus.

More action . . . Though Conoco is inclined to rate the workshop program as perhaps the most important part of its political activity, it is not stopping there.

It intends to become more active in appearances before congressional and legislative committees to help protect interests of the company, stockholders, employes, and customers.

When controversial legislation comes up in Washington or a state capitol, the company wants someone there, properly informed, to give expert testimony or to present its views on pending legislation.

Conoco, however, underlines this: If there is a conflict between the thinking of the individual and the company position when a Conocoan gives testimony, the former must take preference.

Continental is also encouraging its employes to run for elective and accept appointive offices. It would like to see more of its employes serving as members of school boards, city councils, and even higher offices.

The company points with pride to Wyoming where one of its pumpers is a member of the state house of representatives. He pumps for Conoco 10 months of the year. And the company grants him a 2-month leave of absence when the legislature is in session.

Heading up Conoco's political program is Harold Skinner, director of public affairs.

Bearing witness to the importance the company attaches to the program is the fact that this position is attached directly to the office of the president.

Skinner, described by Ham as "essentially a political specialist," is in fact a registered lobbyist in Washington. His talent in this direction will be called upon often. But the greater weight of the company's efforts in Washington will be placed upon making its experts in the various operational branches available for factual testimony before congressional committees.

Florida Offshore Test Dry

GULF OIL CORP. has given up on its latest Florida offshore well—the first drilled on federal acreage off Key West.

However, Gulf was considering seriously last week trying another test. Oil shows have been reported in the tight hole.

Gulf, operator for itself and The California Co., plugged its 1 OCS Block 28 after drilling to 15,294 ft. The projected depth had been 15,000 ft.

The well had no commercial shows, the company said. It is located 37 miles west-southwest of Key West in rank wildcat territory west of the Marquesas.

The lease is one of 22 obtained by Gulf and Calco from the U. S. Government nearly a year ago and is located west of a dry hole drilled on state acreage by Gulf last year.

Gulf said last week it has made no decision on whether to make another try on the federal leases. Offshore Co. was the drilling contractor on the plugged well. Its rig 52 was reported preparing to return to its Louisiana base.

Little Big Inch May Expand

. . . at northern end in effort to fight high rail rates on LPG shipments. This and other LPG pipelining tips given by Neptune brothers at NGAA meeting.

TEXAS EASTERN Transmission Corp. may extend the Little Big Inch in a strategic move to beat the rate squeeze being applied by the railroads.

The first step would be an extension from the terminal at Todhunter, Ohio, to a connection with Buckeye Pipe Line Co.'s products system at Lima, Ohio. A possible second step would be extension of the Houston-Lebanon, Ohio, 20-in. line to Elmira, N. Y.

To keep long-haul business, rails are charging proportionately higher rates to points beyond the pipeline terminus. Rails quote a cheaper through rail rate from Houston to points beyond Todhunter than the combination pipeline and rail rate.

This situation is pushing Texas Eastern toward the extensions, unless rate relief is obtained.

Also, it seems quite likely that within a few months, Texas Eastern will be developing underground storage either near Cleveland or in the Elmira area as a forerunner to a pipeline extension. This is a possible first step in long-range plans to develop pipeline transportation to New York and New England.

This and several other moves in the hotly competitive and growing business of LPG pipelining were reported by Millard K. Neptune, senior vice president of Texas Eastern, and F. B. Neptune, executive vice president of Phillips Pipe Line Co. They addressed the NGAA annual meeting in Houston last week.

Pipelining's most famous brother act, with perhaps the best LPG pipeline observation posts in the industry, also touched on:

. . . **The impending battle** between Southwestern U. S. and Alberta product for markets in the U. S. Midwest.

. . . **Possible modification** of Interprovincial Pipe Line to batch LPG.

. . . **Batching** of high-purity iso-pentane through a Phillips crude line, presaging the more versatile multiproducts lines of the future.

. . . **Importation of** LPG.

Millard Neptune predicted the construction of Mid-America Pipeline from Eunice, N. M., to Minneapolis and Madison, Wis., would at least defer for many years an LPG line proposed from Alberta to the Great Lakes by Pembina Pipeline (OGJ, Apr. 11, p. 83).

Mid-America, which F. B. Neptune calls the most ambitous LPG transportation project in recent times, is the outgrowth of a study made 3 years ago by the Katy and New York Central railroads. NYC has since dropped from the project, but Katy is going ahead with plans to build the pipeline.

The line proposed from Alberta to the Great Lakes got a boost recently when Canada approved gas export permits for four companies. It has been estimated that by 1962 about 92,000 bbl. of gas liquids daily will be available. However, little of these products is likely to reach the U. S. in the near future since Mid-America will be serving the Great Lakes market.

Batching . . . Part of the gas liquids coming from Alberta fields will move to Toronto—and there is a good chance part of the LPG will be batched in a crude line.

Millard Neptune said that when the volume of LPG moving from Alberta to Toronto becomes large enough to justify it, Interprovincial Pipe Line will probably modify its system to enable LPG batching through one of its crude lines.

Eventually, the demand for LPG in Toronto may justify building a straight LPG line.

In regard to batching, F. B. Neptune said Phillips regularly moves high purity iso-pentane through its 10-in., 8-in., and 6-in. crude system from the Texas Panhandle to Phillips' Okmulgee refinery. The material is delivered on specifications with only normal transmix.

Nine other companies batch LPG with conventional products, according to the Neptunes. And at least 22 companies handle some LPG by pipeline. Thirteen lines transport natural gasoline and LPG as a mixed stream or as a mixture with crude oil.

Imported LPG . . . The importation of LPG by tanker, especially by refrigerated tanker, from the Persian Gulf, Venezuela, North Africa, and elsewhere is a definite possibility, according to F. B. Neptune.

The growth of LPG consumption in this country is in the neighborhood of 15% per year and it is not difficult to visualize demand outstripping domestic supply, Neptune said. But first, he said, there is room for more squeeze to be put on gas from our own fields to recover more LPG.

Cement Additive Developed

"FLAC" is the name of a new chemical just introduced by Dowell Division, Dow Chemical Co., for use in oil-field cementing operations.

This additive, when mixed into cement slurries, prevents water in the slurries from escaping into porous rock in the well. This keeps the cement fluid until it reaches the desired depth, permitting proper placement over a wide range of well conditions, and facilitating cementing techniques.

A unique advantage of this new organic fluid-loss additive is its inertness, Dowell reports. It does not react with the cement and, thus, has no adverse effect on pumpability or setting time. It has been used with a number of portland or bentonitic slurries at bottom-hole temperatures as high as 310° F. It imposes no low temperature limits beyond those required for the cement itself.

FLAC has shown excellent results in the Gulf Coast, says Dowell. It has been used in setting pipe or shutting off undesired zones in over 25 wells ranging to 14,000 ft. These jobs were successfully completed with less cement. Long zones with many perforations have been sealed successfully using single-stage squeezes. Wells in the same area previously have required multiple conventional squeezes to obtain shut-off.

Dowell lists these advantages for its new additive: It does not increase slurry viscosity, change slurry thickening time, retard low temperature cements, or lower set strength of cement adversely. The additive does work as an added retarder in some high-temperature cements. It gives reliable and predictable fluid loss control in different concentrations. It works effectively in cement systems other than neat slurries and it dry mixes and handles easily.

Stocks of FLAC are limited at the present time, but an ample supply will be available in several months, Dowell reports.

Hachmuth Wins Top Award

THE NATURAL Gasoline Association of America has conferred on Karl H. Hachmuth of Phillips Petroleum Co., the Hanlon Award, highest honor in the natural-gasoline industry and one of the ranking awards of the petroleum industry.

President of the NGAA, Charles E. Webber, Sun Oil Co., made the presentation at the thirty-ninth annual convention in Houston.

Hachmuth was specifically recognized for long and continued work in the development of equilibrium ratio and enthalpy data and his practical application of that data in extraction and separation processes.

"His experimental determinations," Webber said, "led to basic concepts which have resulted in great advances in petrochemistry and to new and useful products from natural-gas liquids."

A native of southwestern Michigan, Hachmuth received a degree in chemical engineering from the University of Michigan and became a research engineer for a Utah mining company in 1925. He joined Phillips in 1927 as pilot-plant engineer and later was put in charge of all fundamental chemical engineering studies for the company, including design and operation of pilot plants.

Since 1949, he has been staff consultant to the research and development department for Phillips. He has also played a leading part in another research group known as Fractionation Research, Inc., a cooperative project involving several oil companies. He is on the board of directors of the American Institute of Chemical Engineers.

Hachmuth is the twenty-fourth person to receive the Hanlon Award, which is donated annually by E. I. Hanlon, chairman of the board, National Bank of Tulsa, and a pioneer in the natural-gasoline industry.

Karl H. Hachmuth

Rathbone Becomes Jersey's Chief Executive

M. J. RATHBONE last week was elected chief executive officer and chairman of the executive committee of Standard Oil Co. (N. J.). Leo D. Welch was named chairman.

Rathbone takes over as top executive of the world's biggest oil company from Eugene Holman, chief executive officer and board chairman who reaches the mandatory retirement age in May. Rathbone continues as president of the company, a post he has held since 1954.

Welch succeeds Holman as chairman of the board and becomes vice chairman of the executive committee. Myron A. (Mike) Wright was elected executive vice president and a member of the executive committee, effective May 1.

Rathbone joined the Jersey group after receiving a degree in chemical engineering from Lehigh University in 1921. He started as a draftsman at the Baton Rouge refinery. He was named president of Standard Oil of Louisiana in 1936.

This company merged with Esso Standard Oil Co. in 1944 and Rathbone became president of the merged firm. He became a Jersey director in 1949. He currently is serving his first year as chairman of the API.

Welch has been particularly concerned with the company's financial affairs. He joined Jersey in 1944 as treasurer after 25 years with the First National City Bank of New York,

Jersey's Rathbone

during which time he spent many years in South America. He became executive vice president of Jersey in 1958.

Wright started as a roustabout with Carter Oil Co. in 1933 after graduating from Oklahoma State University. He joined Jersey's producing coordinating department in 1946 and was named deputy coordinator in 1949. After hitches with International Petroleum Co. and with Carter as executive vice president, he returned to Jersey as coordinator of world-wide production in 1954 and was elected to the board in 1958.

Holman joined the company in 1919, starting as a geologist in the Southwest, Mexico, and West Indies. He served as chief geologist for Humble Oil & Refining Co. and as producing executive with Venezuelan affiliates. He became a vice president of Jersey in 1942, president in 1944, and chairman of the board in 1954.

Earnings up . . . The change in top leadership of Jersey coincided with a statement of estimated gains during the first quarter of 1960. First quarter earnings of $170 million, or 79 cents per share, were up 2% over the first quarter of last year when earnings were $167 million or 78 cents per share, and up 11% over the fourth quarter of 1959.

The company said substantial gains in the sale of petroleum products, petrochemicals, and natural gas as well as operating efficiency more than offset continued pressure on prices in many of Jersey's markets. Product sales were up 5% over the first quarter and up 3% over the last quarter of 1959.

Gross production of crude and natural-gas liquids averaged 2,556,000 bbl. daily, compared with 2,589,000 bbl. daily the first 3 months last year. Refinery runs averaged 2,893,000 bbl. daily compared with 2,875,000 bbl. the first quarter of 1959.

WORK-HORSE units of "stub" seismic crews are the drill, water, and recording trucks.

Small Seismic Crews Cut Cities Service's Costs

● They're smaller, more mobile, and produce results comparable to full-size crews. Says Cities Service, they look like the industry's crew of the future.

CITIES SERVICE Oil Co. has adopted five-man seismograph crews to handle a major part of its extensive domestic exploration program.

It says the short crews are much more economical, more mobile, more effective in doing supplemental control work, and are as efficient as the 10 to 14-man operating units.

The stub crews operate at 30% of the cost of fully staffed units.

They are less vulnerable to bad weather conditions and consistently chalk up more work hours per assignment.

The small units can change locations in about half the time required for full units in identical areas.

At present Cities Service has four of the five-man crews and three regular-size crews in the field.

"We have been experimenting with the smaller crew since 1954," says Reese H. Tucker, Bartlesville, vice president and manager of the land, lease, and geological division.

"We first used a stub crew for a once-over-lightly check to see what seismic approach should be made in a particular area. This crew was highly mobile, consisted of five men and multipurpose mobile equipment.

"The economies and experience gained from this experimental crew provided the launching point for Cities Service's stub-crew operations. We believe use of the abbreviated crew will be widely adopted by the oil industry for seismic work in the future."

Costs shaved . . . Cities Service has kept detailed books on comparative costs of operating standard and stub crews in comparable areas.

The cost of maintaining a standard crew, with two drills, in a Kansas area was $19,000 for 1 month. And in same area, a short crew operated for 1 month at a cost of $9,500. The shot points made and work completed by the smaller crew compared favorably, in quality and usefulness, with that of the large crew, according to John Armstrong, acting chief geophysicist.

In another comparison checked by Cities Service, a full crew operated 1 month at a cost of $31,000 and in the same county, a stub crew completed a month's work for $12,700.

They're flexible . . . Studies of the flexibility and mobility of both the standard and bob-tailed seismograph crews have been made by Cities Service.

A standard crew worked in seven areas in seven counties in a 12-month period in the Mid-Continent. In the same general area, a five-man crew worked in 14 different locations in 10 counties in three states.

Cities Service says while detailed work of the full crews may have been more extensive in this instance, the value of results of the two units to the company was comparable.

The more frequent moves of the small crews and the shorter time spent on location don't mean their work is less conclusive nor less valuable than that of the large crew, according to Tucker.

He views the broad use of the small seismic crew as a logical and effective approach to problems of:

. . . **Obtaining** additional short-line control in areas already seismographed.

. . . **Evaluating** small blocks.

. . . **Reshooting lines** in areas where previous data was considered unreliable.

. . . **Determining types** of shooting in areas previously considered not responsive to the seismograph.

"As the broader frontiers of seismic exploration dwindle," Tucker emphasizes, "the trend will be toward reevaluation of exploration work already done and use of new seismic work on a small-area scale."

Any time a new discovery develops

PIPELINE

A 67-mile gas line will be built by Pacific Gas & Electric Co. from Kettleman Hills, in San Joaquin Valley, to Morro Bay in San Luis Obispo County, California. The $4-million project will supply natural gas to a PG&E power plant which is being expanded.

Contract for 52 miles of 20-in. and 8 miles of 8-in. in Pecos and Terrell counties, Texas, has been awarded by El Paso Natural Gas Co. to Western Pipe Line, Inc., Austin, Tex. The project will get under way in 2 weeks.

feverish interest in an area not thoroughly checked previously, a stub crew can be boosted temporarily to full manpower in a matter of hours by drafting contract workers on a day-to-day basis.

"The need for big crews is diminishing," Tucker says. "There will be a high priority, in the next few years, on a great volume of infill work. This can be done faster and cheaper by the stub units."

Crews hand-picked . . . Personnel on Cities Service's short crews are capable of doing work in at least two job classifications.

The shooter can double at surveying, the driller can handle jugs or do other work. Members of the smaller crews are selected from key personnel who have proven records of sound service.

The average length of service of small crew members at Cities Service is 9 years. Some party members have 15 to 20 years in seismic work.

Equipment used by the smaller crews is designed to fit reduced manpower, with minor adaptations made on some trucks. Tractor-mounted equipment is used by the small crews in swamp areas. Air-drilling equipment is used when pattern shooting is required or when water drilling is not economical.

Centralized interpretations . . . One factor favoring the small crew is the growing practice of companies in having their seismic interpretations made in one central office.

Stub crews can turn out seismic tapes in the field on a mass scale, leaving evaluation and interpretation to others. This reduces the necessary personnel automatically.

Cities Service is fully sold on the midget crews. Based on its experience to date, the company flatly predicts that the short crew will be a major factor in U. S. exploration efforts.

TAKING part in first weld is Robert Thomas, company president, and . . .

Mid-America Line Under Way

PIPE LAYING began last week on the nation's first major cross-country pipeline built exclusively to transport natural-gas liquids.

The first two spreads on Mid-America Pipeline Co.'s $72-million, 2,300-mile system extending from Eunice, N. M., to Minneapolis and Madison, Wis., kicked off at Pampa, Tex., and Pratt, Kans.

Both spreads were toured by Robert E. Thomas, president, and D. A. Roach, vice president, of Mid-America; and John H. Williams, president, V. E. Butler, vice president, and E. M. Hubach, general superintendent, of Williams Brothers Co.

Initial capacity will be 50,000 bbl. daily of propane, butane, and natural gasoline through the 8 and 10-in. main line to McPherson, Kans. The 8 and 6-in. branches to Minneapolis and Madison will be able to deliver 30,000 bbl. daily of propane only out of McPherson.

Ultimately, capacity into McPherson will be 83,000 bbl. daily and from that point northward, 40,000 bbl. daily in each leg.

Thomas said shippers had informally committed throughput amounting to 75-80% of the initial capacity of the line, which will be operated remotely from the Tulsa headquarters.

BRIEFS . . .

A price of 27½ cents, plus 2½ cents for gathering, has been paid by Amere Gas Utilities Co. for 40 billion cubic feet of natural-gas reserves owned by United Producing Co., a subsidiary of United Carbon Co., in Kanawha and Fayette counties, West Virginia. Amere, a Columbia Gas System subsidiary, will lay a 16-mile 10-in. line from Carbon to Wingrove, W. Va., late this summer.

A unique price-escalation agreement is the means by which Oklahoma Natural Gas Co. is acquiring a growing gas reserve in Kingfisher County, northwestern Oklahoma. Pan American Petroleum Corp. and Apache Oil Co., two of the producers, have signed contracts and the other four are expected to go along. Present reserves are 30 billion cubic feet. Initial price will be 15 cents an M.c.f., escalating to 16.8 cents, the price paid by ONG in Carter-Knox field, southern Oklahoma, when reserves reach 200 billion cubic feet. ONG is connecting four wells with a junction to its system 14 miles from the new reserves.

A 30-mile 24-in. concrete water line will be laid by Gulf Oil Corp. from Goldsmith to Kermit, Tex. The job has been awarded to R. H. Fulton.

Also for Pipeliners . . .

IN THE NEWS: Green River pipeline bid rejected by FPC (p. 81) . . . Little Big Inch may expand at its northern end to fight high rail rates on LPG shipments (p. 84) . . . Pipe laying has begun on the Mid-America line, the nation's first built exclusively to move natural-gas liquids (p. 87).

PLUS THESE TECHNICAL REPORTS: Special API pipeline report (p. 153) . . . Internal coating boosts pipeline gas flow (p. 177).

Heavy-Crude Prices Are Firmer in California

• Discount rates are being reduced and are not applied as frequently as in the past. Some crude contracts running for 6 months are available.

IN SHARP contrast to what's been happening elsewhere in the country, California producers of heavy crude are hopefully witnessing a firming up of prices.

Two cheering developments are:

... A drop in discount sales and a cut in discounts themselves. A lot of low-gravity crude (12°-17° gravity), which formerly was being sold for discounts up to 90 cents a barrel, is now being peddled for spot sale discounts of only 25 cents a barrel.

... An increase in the availability of crude contracts. Paced by Standard Oil Co. of California announcement that it is increasing its heavy-crude purchases, small producers reported contracts are a little easier to come by than in the past couple of years.

An informal survey conducted a couple months ago showed about 90,000 bbl. of heavy crude was being sold at discounts. How much of this is now under contract was not immediately known. Although no other major admitted it was following Standard of California's suit, it was generally conceded other refiners would probably increase their heavy-crude purchases in coming months.

The contracts being made at posted prices are automatically renewed every 6 months unless one of the parties cancels out. Even this relatively short-term contract is a vast improvement over the no-contract conditions under which many small producers have been operating from day-to-day.

There was speculation that Standard of California's heavy-crude purchase program just launched might scoop up as much as 10,000 bbl. daily.

What happened ... A combination of factors are involved in the growing popularity of heavy crudes in California.

Stocks play a major role. At present 13,800,000-bbl. level, residual stocks, for instance, are almost 15 million barrels below what they were a year ago. Crude stocks are down approximately 7 million barrels. Stock levels in both of these categories have substantial effects on heavy-crude production in California.

Prices of heavy crudes, as a result of a series of cuts in the last 2 years, dropped as much as $1 off postings, making it possible in some cases for refiners to process heavy crudes at a greater economic gain than light crudes. Refiners can get the heavy stuff cheap enough to actually get a better net profit out of the barrel than with the more expensive lighter crudes. In addition, better processing results in less residual, which in turn has the effect of lowering resid stocks.

The steady drop in California production is also contributing to the business of firming up heavy-crude prices. Current production of 830,000 bbl. daily is down 10,000 bbl. daily below what it was a year ago.

Welcome trend ... The firm position of heavy crudes is a welcomed change for the long harassed small producer in California.

It's been strictly a hand-to-mouth existence for many as contracts were either canceled or not renewed. At the same time, crude and residual stocks soared to record levels.

Another thing that put the heavy-crude producer in a bind is the fact that in most cases he can't shut in his wells pending better times. Water cuts to 90% are common. The producer faces the prospect of never getting his well back if he shuts it in, so he has to keep it pumping and selling his production.

Some producers reportedly kept their wells on production even when they had to send all the fluid, oil and water, to disposal systems because their storage was full and they couldn't sell it right away. They figured it was better to lose the little production involved than to run the risk of losing the well entirely.

Two other factors point to better days ahead for heavy-crude producers. For one, brokers report there are virtually no wells on the market. And a recent survey showed only about 2,500 bbl. of production shut-in in the state. This includes 1,000 bbl. in Wilmington where it is shut-in as an antisubsidence measure and not due to market conditions.

According to the most recent California Oil and Gas Division statistics, development drilling and reworks are up over a year ago, while abandonments are down, indicating a healthier condition today than a year ago.

Saskatchewan Revises Rules

SASKATCHEWAN'S petroleum and natural-gas regulations have been amended to encourage exploration of the deeper formations in the province.

Minister of Mineral Resources J. H. Brockelbank announced that exploratory permits will now cover a 5-year period; that the cost of a deep test well may be applied to the entire work commitments for the life of the permit; and that royalty-free privileges for one deep discovery will be permitted within each permit area of 75,000 acres or larger.

Brockelbank added that the amendments will give the oil industry more freedom of operation in the exploratory field. Moreover, the expansion of the permit life from 3 to 5 years gives operators 2 years in the low-rental and low work-commitment bracket without compulsory drilling.

PROCESSING BRIEFS ...

M. W. Kellogg Co. is slated to win a prize construction contract. The company will build a 150,000-bbl. crude unit and 47,600-bbl. cat cracker at American Oil Co.'s Texas City refinery. Still to be awarded is the contract to build a 14,600-bbl. alkylation unit. The big crude unit will replace present units and increase the plant's capacity about 10,000 bbl.

The second International Congress on Catalysis will be held in Paris, France, July 4-9, 1960. The 140 papers to be presented will primarily cover heterogeneous catalysis, with sections on kinetics and mechanisms of catalytic reactions, physical-chemical properties of catalysts and catalytic activity, and applied catalysis.

Tennessee Oil Refining has contracted O. L. Olsen Co. to build a natural-gas processing plant near Palacios, Tex. The plant will have a capacity of 55 million cubic feet of gas daily. Production will be about 58,000 gal. of liquids daily. Tennessee Oil Refining will lay a 6-mile 4-in. pipeline from the plant to a products pipeline operated by TGT on the Texas Gulf Coast.

Sohio Runs a Tight Ship at Toledo

• Costs at the 60,000-bbl. plant have been cut 23% with refinery integration. By reducing capital spending, operations right down the line are cut.

LOWER COSTS in capital investment, working capital, utilities, maintenance, and services are among the benefits that go with refinery integration.

That was a large part of the story told by a three-man Standard Oil Co. (Ohio) team at the National Petroleum Association symposium on optimizing and maintaining refinery efficiency.

Refinery integration at Sohio's 60,000-bbl. Toledo refinery has cut costs $12,200,000 or 23% as compared to the cost of a comparable conventional refinery.

Two other ways of improving refinery efficiency were reviewed in the symposium: Use of computers and contract maintenance. Both help but integration stands head and shoulders above the others.

These are some of the advantages of integration as seen by S. Arthurs, head of Sohio's design section in process engineering:

... **Capital requirements** are vastly reduced by cutting down on intermediate tankage and using fewer pumps, exchangers and furnaces, and less piping. The savings added up to $7.9 million.

... **Less working capital** is required. Because there is less equipment to do a given job, refinery stores are reduced. The big item is the stocks not in intermediate tankage. This savings hit $4.3 million.

... **The utilities bill** is reduced about 15%. Big reason is the more efficient handling of heat. No stream is cooled unless required by the processing operation.

Sohio's Savings at Toledo

	Millions of dollars	Per cent
Process facilities	3.0	11.0
Utilities	0.3	5.5
Tankage	4.6	49.0
Working capital	4.3	48.0
Total	12.2	23.0

... **Maintenance costs** are automatically brought down since there is less equipment. Turnarounds at Toledo are contracted, which requires less permanent personnel.

... **Services** are greatly reduced. This includes fewer laboratory tests, fewer charts to planimeter, fewer tanks to gauge, fewer operating plans to work out, etc. It has been possible to operate on a one-laboratory-sample-per-day basis on each process stream.

T. S. Clift, superintendent of the process control system, heads a 22-man organization including 15 instrument men. It was found, he said, that about 100 major instruments justifies one instrument man.

The Toledo refinery is saving money on air coolers and stream analyzers. There are 11 air cooling devices at the plant. These have worked out "beyond our expectations. They are virtually maintenance - free," Arthurs said.

The refinery makes extensive use of stream analyzers and they have been kept on stream nearly 100% of the time. This high service factor is critical in certain areas since some equipment depends on the results of analyzers for safe and efficient operation. More analyzers are being installed.

F. L. Lichtenfels, process superintendent, reviewed the operation of the refinery and cited these advantages:

The plant is essentially in blending balance on an over-all refinery basis most of the time. This means that it is possible to ship out of finished product inventory, blend on the fly, and be more responsive to sudden shifts in demand.

By consolidation and concentration of equipment, significant economies in the quantity of process manpower are achieved. The refinery is run by 17 operators per shift.

Processing orders for the entire plant for a 24-hour period are given to all operators and operating foremen. By use of this device and highly trained supervision, it is possible to operate on the single laboratory sample per day basis for each process stream. This is done without quality problems and without giving away quality.

Boiler facilities are integrated with hydrocarbon processing units permitting singularly fine supervision to balance the unit utilitywise, Lichtenfels said.

He said there is also little opportunity for an inadvertent error in pumping the wrong material into a section. As a result, "we haven't filled up a tank with something that has either to be processed or blended off or set up special operating conditions somewhere to handle it."

A double explosion in the glycerin unit at Dow Chemical Co.'s plant in Freeport, Tex., killed one man and injured eight others last week. Gerald D. Benedict, 34, Angleton, Tex., a plant operator, was killed while loading a small tank from a methyl acetylene storage tank. The smaller tank exploded and then the larger. The explosions caused about $50,000 damage and destroyed a warehouse. Cause of the accident was not disclosed.

St. Paul Ammonia Products, St. Paul, Minn., plans to expand the capacity of its Pine Bend plant from 88,000 to 110,000 tons per year of anhydrous ammonia and nitrogen solutions at a cost of more than $4 million. Construction will get under way this fall with completion planned by the spring of 1961.

An ammonia plant, costing about $15,000,000, will be constructed near Joplin, Mo., by Solar Nitrogen Chemicals. The plant will produce anhydrous ammonia, urea, and related products. It will be operated by Atlas Powder Co., a co-owner of Solar with Standard Oil Co. (Ohio). Completion is expected in a year.

Also for Refiners . . .

IN THE NEWS: Field-processing trends feature growth of the very big and very little field plants (p. 71) . . . Union abandons plans for processing shale oil (p. 73) . . . California Standard offers American motorists first methyl fuel (p. 74) . . . Demand in next 5 years will sop up world-wide oversupply, says economist for New York bank (p. 76) . . . IPAA sets out to get further cuts in imports (p. 77) . . . IPAA trims its forecast for 1960 demand to a gain of only 2.9% (p. 80) . . . Sohio's integration plan cuts operating costs 23% at Toledo refinery (p. 89).

PLUS THESE TECHNICAL REPORTS: The annual field-processing section (pp. 94-141) . . . Refining cost index (p. 103).

Soviet Output Up; Goals Are Raised

• But it is not all vodka and caviar. The sour note is high production costs.

RUSSIA'S booming oil-producing industry is having its share of trials and tribulations.

The soft spots are not readily apparent from figures showing the country's production gains. Output the first quarter of this year averaged 2,843,000 bbl. daily, up 16% over the first 3 months of last year.

This performance has caused the Russians to raise their production target for 1960 to 145 million metric tons, or about 2,900,000 bbl. daily. This is 1-million tons, or about 20,000 bbl. daily, more than the goal set last fall. Natural-gas output the first quarter rose 30% to 4,600,000 M.c.f. daily.

At the same time, the Soviet industry has its problems. These do not appear serious enough to threaten a disruption of the crude-producing industry, but they do add to the cost of Soviet oil. This cost may be one of the key factors to indicate the Russians are serious when they say they do not plan price wars to move their oil in foreign trade.

The consequences of the Soviet pricing policy could be far reaching. Russia sold a half-million barrels daily of crude and products in export markets last year, a rise of 40%. More than half of the oil was delivered to free-world markets.

There is no doubt about the Russians ability to produce all the oil they need for themselves, plus extra supplies for export, or that the industry is growing more modern and efficient. The State Planning Committee (Gosplan), in reviewing plans for this year notes with satisfaction that:

... **An 11.2% rise in crude** production will be achieved with an increase of only 2% in development drilling.

... **Slim-hole drilling** will double and account for 33.6% of total footage.

... **Exploration drilling** will exceed the footage for development drilling for the second straight year.

... **400 new rigs** will be delivered as replacements for obsolete equipment.

On the other side of the ledger, Russian planners probably can't ignore production costs when they offer crude in foreign markets. Each barrel of crude produced for export takes away steel, electricity, manpower, and equipment-manufacturing capacity sorely needed by other industries in the country.

SNOW AND ICE hamper a Russian worker on the monkey board of a drilling rig in the Second Baku area, between the Volga River and the Ural Mountains.

These costs are kept up by an oilfield technology that in many respects lags behind the West's, and by oil pools that are more difficult to produce than fields of competitive areas, such as the Middle East or North Africa.

Here are a few of the reasons why Russian oil probably isn't cheap:

... **Water-flood projects** this year will produce 68% of Russian crude.

... **Bottlenecks in completing** wells after drilling and in construction of field outlets in some areas are the rule, rather than the exception.

... **Pumping is needed** in many new fields from the start.

Cite gains . . . While the Russians admit they have problems, they are quick to point out their achievements, sometimes making comparisons with U. S. operations.

They say that only 50 to 100% more wells are completed nowadays than before World War II, while crude output has increased twelve-fold. The USSR produced 18 tons of crude per meter drilled in the 1956-58 period, in comparison with 6 tons, or about 42 bbl., for each meter drilled in the U. S. Another claim is that 50 to 60% of all wildcats produce oil or gas, in comparison with a success ratio of less than 20% in the U. S. last year. The Russians, however, do not say whether their figures include noncommercial wells.

The 1960 drilling schedule calls for a total of 27,415,000 ft. of hole. Exploration drilling will account for 15,118,000 ft. of this, a gain of 1,686,000 ft. About 9,203,000 ft. of drilling will be in the slim-hole category, or 33.6% of total footage, up from 16.4% last year.

There also will be up to 3,000 fracturing jobs on Soviet wells this year,

and automatic and remote control equipment will be installed on 3,500 wells. Equipment manufacture will include about 125 BU-75, medium depth rigs, which are highly regarded, along with 3,750 small-diameter turbodrills.

Drawbacks . . . The emphasis on slim-hole drilling is not as impressive when the Russian meaning of the term is known.

Until recently, Russian bits have been mainly 9.6, 10.6, and 11.6-in. diameter, and anything less than 9.6 in. is considered a slim hole. One Russian official has said that because of larger diameter drill pipe and casing, metal consumption per meter of hole is about 121 lb. in Russia, against 71.5 lb. in the U. S.

Russia also is spending heavily for water-flood facilities. It plans to inject 202 million cubic meters of water into formation this year. This is about 3,500,000 bbl. daily of water, an increase of 24%.

The 8% gain in drilling this year will be accounted for by the 400 rigs replacing old equipment. The total number of rigs in service will remain at about 1,000, the same level as during the past 2 years.

Drilling performance by and large has increased steadily for the past decade. Development drilling per rig month increased from 2,087 ft. in 1950 to an estimated 3,560 ft. last year. During the same period, performance on wildcat wells rose from 682 ft. per rig month to 1,371 ft. per month.

There are indications, however, that development drilling performance slipped last year. The 3,560-ft. figure mentioned by Gosplan is well below a figure of 3,937 ft. per month for 1958 mentioned in a paper given at the Fifth World Petroleum Congress. The original plans for 1960 development drilling have been reduced by 690,000 ft.

The biggest complaint by the Russians is chronic disorganization at fields under development. In Tataria, for example, 560 wells were drilled in about 21,000 rig days 2 years ago. But another 29,000 rig days were spent in testing, or simply in idleness, on the holes, or about 52 extra days per well.

Some development wells are idle for months after drilling until water flooding increases pressure sufficiently for natural flow. Soviet officials are pressing for faster drilling of flood wells and delivery of injection equipment. Other delays are caused by an acute shortage of centrifugal, bottom-hole pumps, delays in laying field lines, and in the installation of pumping jacks, traps, and other surface facilities.

Russian officials also want to shave drilling time. Actual drilling on an average Russian well decreased 48.5% from 1950 to 1958. Cementing time was reduced 35.7% in the same period, and repair work dropped 12.9%. But time spent on round trips increased 30.2%, and time spent on auxiliary work remained unchanged.

The Soviets also plan to extend cluster drilling this year, a method in which two or more holes are sunk simultaneously with one rig. They are curtailing the setting of production casing in wildcats which prove dry.

Mobil-CEP Have Strike in the French Sahara

- The discovery is near a crude line being built to the coast of Tunisia.

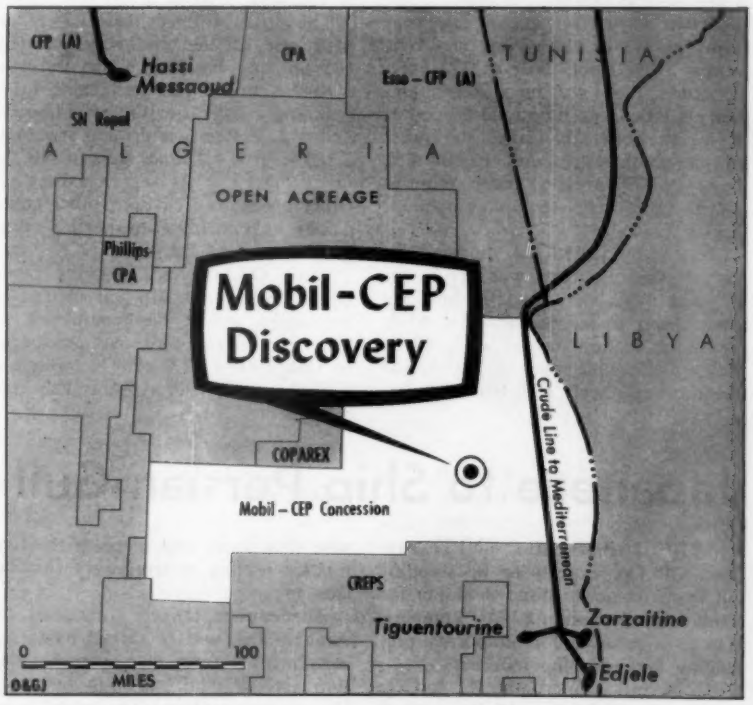
MOBIL International has become the first American company to share in a strike in the French Sahara, with part interest in a 1,900-bbl. wildcat near the Libyan border.

The discovery well, Ohanet 1, lies about 350 miles south of the Mediterranean Coast. It is about 30 miles west of a 460-mile 24-in. crude line being built to the coast of Tunisia from Edjele, Zarazaitine, and Tiguentourine oil fields.

Ohanet 1 flowed at the rate of 1,900 bbl. daily of high-gravity crude on a drill-stem test through a 1-in. choke. The tested zone is at about 7,740 ft. Tests in formations immediately above the oil zone showed "substantial" quantities of natural gas.

Mobil moved into the Algerian oil play at the end of last year by taking a 25% interest in rights to about 8 million acres held by CEP and associated companies. CEP has explored the area for years and is operator for the program.

Mobil considers the discovery of particular importance because it gives the company a source of French community crude. Companies refining oil in France have been asked by the government to take most of their crude from French areas. Mobil has a 21,000-bbl. refinery at Gravenchon and a 27,000-bbl. plant at Frontignan.



Ohanet is the company's third find in North Africa. Two discoveries have been made about 600 miles to the east in Libya, in Amal 1 and Hofra 2. Mobil also has half interest in a 10-million-acre concession held by SEREPT in Tunisia.

In West Africa, Mobil is exploring in the Gabon and Congo Republics, and in Equatorial Africa.

Libya's First Crude Export Terminal Planned

ESSO Standard (Libya), Inc., has selected a site for a tanker terminal to handle crude exports from its prolific Zelten field.

Esso will build its facilities at Marsa el Brega, on the Gulf of Sirte. The terminal will be located about 100 miles north of Zelten. It will be supplied by a 30-in. crude pipeline following approximately the shortest straight-line route between the field and the Mediterranean.

The export terminal will be the first in Libya planned by any of the operators with new-found crude production. It will give the Jersey Standard affiliate a head start in putting its Libyan oil on world markets.

Actual work on the site cannot start until the Libyan Government gives formal approval. But terminal tankage and 100 miles of 30-in. pipe are on order, with deliveries to start in mid-1960.

Zelten field . . . Esso has completed five out of five wells as producers at Zelten, located in the southwestern corner of the 25,690-sq.-km., or about 9,919-sq.-mile, Block 6.

Zelten 1 was completed last year as by far the best discovery in Libya, testing 17,500 bbl. daily of 37°-gravity crude. Flow is from a 205-ft. section of Paleocene limestone topped at 5,460 ft. Zelten 2, drilled 4.5 miles to the southwest, tested 15,000 bbl. daily of 39°-gravity crude from a 145-ft. Paleocene section topped at 5,770 ft.

Zelten 3, located 5.4 miles southeast of the discovery, was dry in the original pay, but tests 100 bbl. per hour from a second zone, a 45-ft. limestone section topped at 7,166 ft. Zelten 4, located south of No. 3, and the most southerly well drilled so far in the field, tests at 2,500 bbl. daily.

The fifth well, drilled 3.7 miles northwest of the discovery, yielded 101 bbl. per hour on a test through a ½-in. choke. The well came in a year and a day after the spudding of Zelten 1. Zelten 6 is drilling ahead at 6,885 ft. It is 4.1 miles west of No. 5.

Other operators . . . Four other companies have discoveries in the same general area of Libya.

Oasis Oil, operator for the Ohio Oil, Continental Oil, and Amerada Petroleum group, has completed at least five oil and three gas producers in Dahra field in Block 32, where a find also was made at Bahi. The best Dahra well tests at 8,000 bbl. daily.

Mobil Oil has made its second discovery at Hofra 2, on Block 11, which tests 1,500 bbl. daily. Mobil's Amal well on Block 12 is in the 865-bbl.-daily class. Libyan American and a second Jersey Standard affiliate have three producers on Block 17, in the Mabruk area. Amoseas has a 3,650-bbl.-daily well at Beda, on Block 47.

Oasis also has a promising find at B1-59, south of Zelten. In eastern Libya, Oasis has a possible find at A 1-26. Elsewhere in eastern Libya, Royal Dutch-Shell has a find at Bir Tlacsin, Gulf made a discovery at Emgayet, and in the southeast Esso has a noncommercial find at Atshan.

Japanese to Ship Persian Gulf Oil This Fall

THE JAPANESE-OWNED Arabian Oil Co. expects to be shipping oil from its newly discovered Persian Gulf field by autumn. The company has let a contract for temporary producing and shipping facilities.

McDermott International, Inc., a subsidiary of J. Ray McDermott & Co., will erect the facilities at the site of Arabian Oil's production offshore from the Neutral Zone.

Neither Arabian Oil nor McDermott disclosed details of the facilities, but the Journal learned they will consist of a separating station, with nine flow lines, and mooring for five tankers serving as temporary floating storage.

The storage tankers, furnished by Arabian Oil, will be served by transmission lines from the separation station and be equipped with lines for the seagoing tankers. The entire operation will be offshore.

The setup is a temporary one, similar to past operations of Superior Oil Co. and Sun Oil Co. in Venezuela's Lake Maracaibo. Eventually Arabian Oil will build permanent facilities, now being designed.

The temporary facilities will put the Japanese into the shipping business this year. Construction will start by the end of September, and it is possible Arabian Oil will move its first crude by late October.

The Japanese have been anxious to develop the new field as quickly as possible. The discovery well rated at better than 6,000 bbl. daily and a stepout well has been drilled to a total depth of 5,570 ft. Reportedly, the second well will be a better producer than the first, which found pay at 4,920 ft.

World Output Slips

• But free-world production, outside U. S., stays above 10-million barrels daily for second month.

FREE-WORLD crude production continued at a near-record level in February, slipping only about 18,000 bbl. daily from the all-time high of the preceding month.

While foreign production dropped slightly, output remained above 10-million barrels daily for the second straight month. Rising domestic production crept upward again with a gain of 11,000 bbl. daily, the sixth rise in a row.

Middle East output slid 78,800 bbl. daily as a result of a 131,400-bbl.-daily decline in Kuwait. Gains elsewhere, including an all-time record of 1,245,800 bbl. daily in Saudi Arabia, were not able to make up the difference.

Algerian output of 127,400 bbl. daily marked the third consecutive rise since the opening of the Hassi Messaoud crude pipeline from the French Sahara. Another country in the spotlight, Argentina, enjoyed an all-time record of 139,500 bbl. daily.

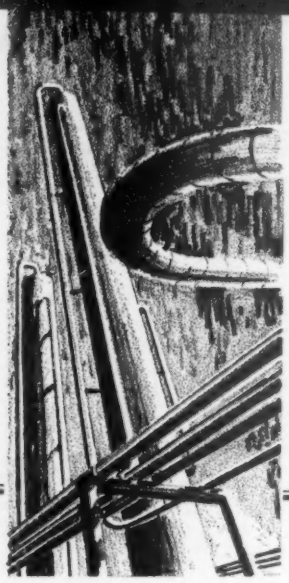
TREND OVER THE LAST YEAR

	Western Hemisphere less U.S.	Middle East	Total free world outside U.S.
1959			
February	4,436.3	4,426.3	9,635.4
March	4,220.6	4,634.2	9,680.7
April	3,910.4	4,646.4	9,396.5
May	3,773.6	4,571.4	9,181.0
June	4,111.5	4,467.9	9,428.7
July	3,914.8	4,532.5	9,293.2
August	3,862.1	4,659.7	9,344.9
September	3,887.5	4,635.5	9,396.4
October	4,069.6	4,688.2	9,629.8
November	4,123.2	4,820.7	9,877.9
December	4,218.5	4,682.0	9,861.5
1960			
January	4,316.5	5,065.3	10,334.7
February	4,359.5	4,986.5	10,305.2

World-Wide Crude Production: Daily Average in Thousands of Barrels

Country—	Feb. 1960	Jan. 1960	Feb. 1959
Western Hemisphere			
Argentina	139.5	136.9	126.9
Bolivia	9.1	9.1	7.9
Brazil	76.0	76.0	52.0
Canada	575.0	605.0	563.4
Chile	18.8	18.8	16.4
Colombia	156.9	156.9	139.1
Cuba	0.5	0.5	0.4
Ecuador	7.8	7.6	7.6
Mexico	265.0	265.0	267.6
Peru	47.2	47.2	49.3
Trinidad	117.7	114.8	109.8
Venezuela	2,946.0	2,878.7	3,095.9
Total	4,359.5	4,316.5	4,436.3
Europe			
Austria	45.3	45.3	49.0
France	36.9	35.8	28.2
West Germany	101.4	102.2	92.6
Italy	30.8	29.0	28.5
Netherlands	33.9	33.3	33.4
United Kingdom	1.7	1.7	1.6
Yugoslavia	12.1	12.1	9.6
Total	262.1	259.4	242.9
Middle East			
Bahrain	45.0	45.1	45.1
Iran*	1,008.0	999.0	829.0
Iraq†	920.0	903.2	807.1
Israel	2.0	2.0	2.0
Kuwait	1,452.0	1,583.4	1,342.3
Neutral Zone	122.0	122.0	105.7
Qatar	184.4	182.6	176.4
Saudi Arabia	1,245.8	1,221.2	1,112.0
Turkey	7.3	6.8	6.7
Total	4,986.5	5,065.3	4,426.3
Other Asia			
British Borneo	110.0	110.0	107.0
Burma	10.5	10.5	9.1
India	8.5	8.5	8.5
Indonesia	325.0	335.0	290.0
Japan	9.0	9.0	7.8
New Guinea	4.3	4.2	5.0
Pakistan	5.9	5.9	5.9
Total	473.2	483.1	433.3
Africa			
Algeria	127.4	110.9	11.8
Angola	0.9	0.9	0.8
Egypt	59.3	59.5	62.2
Gabon	12.1	14.9	13.4
Morocco	2.2	2.2	1.7
Nigeria	22.0	22.0	6.7
Total	223.9	210.4	96.6
Free World			
Foreign	10,305.2	10,334.7	9,635.4
United States	7,241.0	7,230.0	7,187.0
Total	17,546.2	17,564.7	16,822.4
Communist Countries in Soviet Orbit			
Romania	235.0	235.0	235.0
Russia	2,843.0	2,843.0	2,420.0
Others	100.0	100.0	60.0
Total	3,178.0	3,178.0	2,715.0
WORLD TOTAL	**20,724.2**	**20,742.7**	**19,537.4**

Figures are from reliable industry reports or government sources. Estimates are made where complete reports are lacking. *Includes estimated 6,000 bbl. daily from Naft-i-Shah field not operated by Consortium companies. †Includes estimated 3,500 bbl. daily from Naft Khaneh field, operated by Iraq Government.



Beginning . . .

SPECIAL FIELD PROCESSING SECTION

Featuring selected papers from the NGAA annual convention held in Houston, April 27-29, 1960:

● Absorber design now simplified. ● Where gaps still exist in enthalpy data. ● How automated are you? ● Planning for mined underground LPG storage. ● Transfer hose found to cause LPG contamination.

Also . . . ● Journal Field-Processing Survey ● Report on new gasoline-plant construction.

Absorber design now simplified

● Using the new method described here reduces the tedious calculations to 2 to 3 hours' time by an experienced or part-time absorption calculator

BY SPENCER H. LANDES AND F. W. BELL
Brown & Root, Inc.

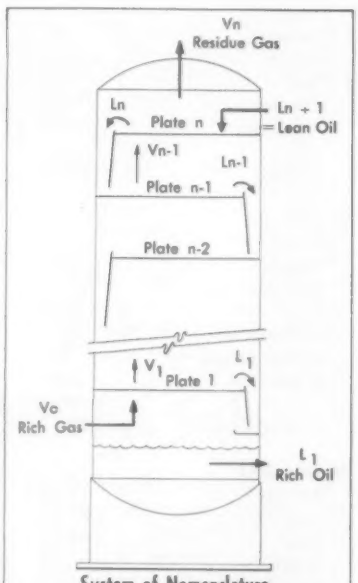
THE GRAPHICAL METHOD of absorber design presented in this article hits a happy medium between a rigorous plate calculation and the shortest empirical method. The inexperienced or part-time absorption calculator should be able to design safely by this method.

This type of design has been applied successfully to both high and low-pressure absorbers, normal and subzero temperature absorbers, and reabsorbers for recovery of ethane and heavier hydrocarbons. Operating data substantiate the accuracy and adaptability of the method. With a little practice, the complete calculation can be made in 2 to 3 hours. Handy forms are presented to assist in speeding up the calculations.

Data sources. Equilibrium values for absorption-oil system have been studied by many researchers. Among the most popular data for heavy-oil systems at atmospheric temperature is that of Weber[12]. Composition of the liquid phase has a pronounced effect on component K values. Some authors have found it expedient to correct the methane K value for composition effect in heavy-oil systems at atmospheric temperature. In low-temperature absorption where light oils are used, the phase compositions also have an effect on the propane K values. Correlations such as the Benedict-Rubin-Webb[1] equation of state have been used successfully to give the effect of phase composition on equilibrium data. This correlation, in terms of molal average boiling point of each phase, does not always agree with K data taken from the NGSMA Data Book at the corresponding convergence pressure. The absorber operating conditions wherein composition exerts a great influence on equilibrium data, and indirectly, the absorber oil rate, will be discussed later.

Heat data for absorber heat balances should be selected with as much care as K data. We have found that more accurate heat balances are obtained by using a combination of heats-of-absorption for phase change and sensible heat for no phase change

Author Landes is now associated with Delta Tank Manufacturing Co.



System of Nomenclature for Absorber Calculations

A Absorption factor for any component $= \frac{L}{VK}$
K Equilibrium coefficient for any component $= Y/X$
L Mols of liquid leaving any tray in absorber
T Temperature °F.
V Mols of vapor leaving any tray in absorber
X Mol per cent of component in liquid phase
Y Mol per cent of component in vapor phase

Subscripts
o Rich gas to absorber
1 Bottom tray of absorber
n Top tray at absorber

By: S.H.L.

Client

Service: Main Absorber

Based on: Test Data Process Sheet: By: Date:

Absorber: PSIA 595 Actual Trays 24 Theo. Trays: 6

Lean Oil: API 38.0 Sp. Gravity: Mol. Wt.: 190 Gal/Mol: 27.3

Conditions: Rich Gas Temp: 78 Lean Oil Temp: 81 Assumed Ave. Temp 110

Sheet Col.	1	2	3	4	5 Rich Gas Mols	6 Mol %	7 Pounds	8 K 110°	9 X Equil.	10 % Key Desired	11 A	12 % Equil.	13 Corr. X	14 Mols. Key Desired
1	N_2				2042			27.5			.0095			
2	C_1				53162			6.6			.0396			
3	C_2				15843			1.39			.1881			
4	C_3				8560	10.32		0.502	0.64	51.5	.523	98.8	20.39	4408
5	C_4				643			0.247		87.6	1.06			
6	C_4				2055			0.187		95.6	1.40			
7	C_5				279			0.089						
8	C_5				266									
9	C_6				68									
10	C_{7+}				41									
11														
12											0.			
13														
14														
15														
Σ					82959									

L/V = K·A For Key: 262 = 0.5 x .523

R.O. = Mols Key · 100 / Corrected X: 4408 x 100 / 20.39 = 21618

16 Mols. Absorbed	16 Material & Heat Data	17 Res. Gas Vn	18 Yn %	19 K °F	20 Y_n/K	21 Ln	22 Data	23 K	24 Y_n/K	25 Ln	26 Data
1 19	Abs'd HC's	2023	2.88	27.5	0.10	16	Abs'd HC's				Abs'd HC's
2 2105	Lbs 513434	51057	72.66	6.6	11.01	1721	Lbs 181464				Lbs.
3 2980	MW 40.6	12863	18.31	1.39	13.17	2060	MW 31.16				MW.
4 4408		4152	5.91	0.50	11.82	1849					
5 563	C 2	80	0.11	0.247	.45	70	C 2				C
6 1966	Hv 4520	89	0.13	0.187	.69	108	Hv 5150				Hv
7 279	Hl 1640						Hl 1850				Hl
8 266	ΔH 2880						3300				
9 68	C 3	Lbs. 1,451,936					C 3				C
10 41	Hv 6250						Hv 7170				Hv
11	Hl 1920	MW					Hl 2220				Hl
12	ΔH 5330						4950				
13	Ave. ΔH BTU/Mol	S.G.					Ave ΔH BTU/Mol				Ave ΔH BTU/Mol
14	= 4740						= 3440				=
15		Lean Oil			62.76	9815					
16 12695		70264	100.00		100.00	15639					
La 8923											
Ra 21618											

Top Tray Heat Balance		27 1st. Trial	28 2nd. Trial
Assume t_n = 110 ; t_{n-1} = 117			
1) Heat from Residue Gas	= ($t_{n-1} - t_n$) x Cp x Lbs V_n /24 = 7 x .59 x 1,451,936/24	250,000	
2) Heat of Absorption	= Ave. ΔH x Mols. Abs'd = 3440 x 5824/24	835,000	
3) Heat to Lean Oil	= (1) + (2) =	1,085,000	
4) Δt of Lean Oil	= Δt x (3) ÷ (Lbs LO x Cp) = 1,085,000 x 24/9815 x 190 x .48	29°	
5) Check t_n vs assumed	= t_n = 81 + 29 Δt	110°	

Remarks:

Preliminary-calculation sheet A-1

By S.H.L.

Client

Service: Main Absorber

Based on: Test Data Process Sheet: By: S.H.L. Date: 7-58

Temperature and L/V on Tray Below Top, t_{n-1} & $(L/V)_{n-1}$

Sheet Col.	1 V_n Mols.	2 L_n Mols.	3 V_{n-1} Mols.	4 Y_{n-1} %	5 K 117°	6 Y_{n-1}/K	7 L_{n-1} Mols.	8 Date	9 Heat Balance (Two Tray)
1 N_2	2023	16	2039	2.68	27.5	0.10	17	Abs'd HC's	Assume t_{n-2} = 117°
2 C_1	51057	1721	52778	69.36	6.7	10.35	1727	Lbs 227406	Heat from Res. Gas: 1451936/24 x .59 = 117-110 = 250,000
3 C_2	12863	2060	14923	19.61	1.44	13.62	2273	MW 33.1	Heat of Absorption: 6871/24 x 3450 = 985,000
4 C_3	4152	1849	6001	7.89	.53	14.89	2484		Δt of Lean Oil: 1,235,000x24 / 9815 x190 x.48=33.2
5 C_4	80	70	150	0.20	.26	0.77	128		Calculated t_{n-1} 114.2 vs 117°
6 C_4	89	108	197	0.26	.20	1.30	217		(L/V)n-1 = 0.22
7 C_5						.15	25		
8 LO		9815				58.82	9815		
Σ	70264	15639	76088	100.00		100.00	16686		

Bottom Tray Temperature (R.O. Temperature)

Assume Rich Oil Temperature, t_1 = 100

1) Heat to Residue Gas = ($t_n - t_0$) x Cp x Lbs V_n = (110-78) x .59 x 1451936/24 = 1,140,000

2) Heat of Absorption = ΔHabs x Mols HC = 4740 x 12695/24 = 2,500,000

3) Heat to Lean Oil = (2) − (1) = = 1,360,000

4) Δt of Lean Oil = (3) ÷ [Lbs LO x Cp] = 1,360,000 x 24/9815 x 190 x .48 = 36.5

5) Check t_1 vs assumed = t_1 = t_{LO} + Δt = 81 + 36.5 = 107.5 vs 100°

L/V on Bottom Tray = $(L/V)_1$

Assume equal number mols gas absorbed each theo. tray except top.

solving for V_1, mols leaving bottom plate = Vo − [(From Sheet Col.5 − Col.21) / (Trays − 1)]

V_1 = Col.5 − [(Col.15 − Col.21) / (Trays − 1)]

V_1 = 82959 − (22510 − 15639)/5 = 81,588

$(L/V)_1$ = 22,510 / 81,588 = 0.276

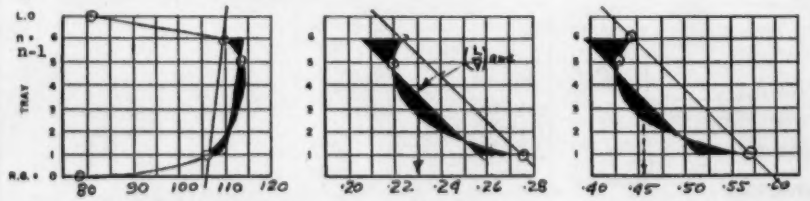
$(L/V)_n$ = 15,639/70264 = 0.223, A_n = .223/50 = .445

$(L/V)_{n-1}$ = 0.22, A_{n-1} = .22/51 = .433

$(L/V)_1$ = .276, A_1 = .276/.485 = .569

Trial II Lean Oil = $9815\left(\frac{A_{ave}}{A_{Arg.}}\right) = 9815\left(\frac{0.523}{0.46}\right) = 11{,}100$

Graphical Solution For Average Absorption Factor For Key.



t ave = (114 + 109)/2 = 111.5 ave = .23 ave (.39 + .53)/2 = .46

Preliminary-calculation sheet A-2

By: S.H.L.

Client

Service: Main Absorber

Based on: Test Data Process Sheet: By: Date:

Absorber: PSIA 595 Actual Trays: 24 Theo. Trays: 6

Lean Oil: API 38.0 Sp.Gravity: Mol. Wt.: 190 Gal/Mol: 27.3

Conditions: Rich Gas Temp: 78 Lean Oil Temp: 81 Assumed Ave. Temp.

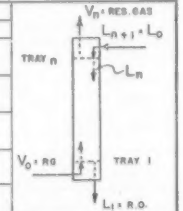
Sheet Col.	1	2	3	4	5 Rich Gas Mols	6 Mol %	7 Pounds	8 K 111.5	9 X Equil	10 % Key Desired	11 A	12 % Equil.	13 Corr. X	14 Mols. Key Desired
1	N_2				2042			27.5		.93	.0093			
2	C_1				53162			6.6		3.88	.0388			
3	C_2				15843			1.39		18.90	.189			
4	C_3				8560	10.32		.505		51.5	0.523	98.8		4408
5	C_4				643			.248		88.5	1.06			
6	C_4				2055			.188		96.0	1.40			
7	C_5				279			.090		100				
8	C_5				266					100				
9	C_6				68					100				
10	C_{7+}				41					100				
11														
12														
13														
14														
15														
Σ					82959									

L/V = K·A For Key = ____

R.O. = Mols Key · 100 / Corrected x = ____

15 Mols. Absorbed	16 Material & Heat Data	17 Res. Gas Vn	18 Yn %	19 K 110°F	20 Yn/K	21 Ln	22 Data	23 K	24 Yn/K	25 Ln	26 Data
1 19	Abs'd HC's	2023	2.88	27.5	.10	18	Abs'd HC's				Abs'd HC's
2 2063	Lbs 512470	51099	72.64	6.6	11.01	1945	Lbs 203954				Lbs
3 2926	MW 41.51	12917	18.36	1.39	13.21	2334	MW 31.07				MW
4 4408		4152	5.90	0.50	11.80	2084					
5 569	C 3	74	.10	.247	.40	70	C 3				C
6 1973	Hv 6220	82	.12	.187	.64	113	Hv 7070				Hv
7 279	HL 2100	-		.089			HL 2170				HL
8 266	Δ H 4120						4900				
9 68	C 2	Lbs 1453474					C 2				C
10 41	Hv 4520						Hv 5120				Hv
11	HL 1800	MW 20.66					HL 1820				HL
12	Δ H 2720						3300				
13	Ave. ΔH, BTU/Mol	S.G. .712					Ave. ΔH, BTU/Mol				Ave. ΔH, BTU/Mol
14	=						= 3430				=
15		L.O.			62.84	11100					
Σ 12346		70347	100.00		100.00	17664					
L.O. 11100											
R.O. 23446											

Top Tray Heat Balance	27 1st. Trial	28 2nd. Trial
Assume t_n = 108 ; t_{n-1} = 114		
1) Heat from Residue Gas = $(t_{n-1} - t_n) \times Cp \times Lbs\ V_n$ = 6 X .59 x 1453373/24	213,000	
2) Heat of Absorption = Ave. ΔH x Mols. Abs'd = 3430 x 6564/24	928,000	
3) Heat to Lean Oil = (1) + (2) =	1,141,000	
4) Δt of Lean Oil = Δt = (3) ÷ (Lbs. LO x Cp) = 1141000 x 24/11100 x 190 x .48	27°	
5) Check t_n vs assumed = $t_n = t_{LO} + \Delta t$ = 81 + 27	108°	



Remarks:

Final-calculation sheet A-3

By: S.H.L.

Client

Service: Main Absorber

Based on: Process Sheet: By: Date:

Temperature and L/V on Tray Below Top, t_{n-1} & $(L/V)_{n-1}$

Sheet Col.	1 V_n Mols.	2 L_n Mols.	3 V_{n-1} Mols.	4 Y_{n-1} %	5 K 112°F	6 Y_{n-1}/K	7 L_{n-1} Mols.	8 Date
1	H_2 2023	18	2041	2.65	27.5	.10	20	Abs'd HC's
2	C_1 51099	1945	53044	68.97	6.6	10.45	2040	Lbs 276114
3	C_2 12917	2334	15251	19.83	1.39	14.27	2785	MW 32.80
4	C_3 4152	2084	6236	8.11	.505	16.06	3134	
5	C_4 74	70	144	.19	.248	.77	1450	7100
6	C_4 82	113	195	.25	.188	1.33	260	5000
7	C_5					.15	29	5150
8	LO					56.87	11,100	1980
Σ	70341	6564	76911	100.00		100.00	19518	5930

Heat Balance (Two Tray)

Assume t_{n-2} = 114°

Heat from Res. Gas = 2 x .59 x 1453474/24 = 71,500

Heat of Absorption = 3560 x 8468 / 24 = 1,260,000

Δt of Lean Oil = 1331,500 x 24 / 11,100 x 190 = 31.4°

Calculated t_{n-1} = 112.4° vs 114°

$(L/V)_{n-1}$ = .0255

Bottom Tray Temperature (R.O. Temperature)

Assume Rich Oil Temperature, t_i = 105°

1) Heat to Residue Gas = $(t_n - t_o) \times Cp \times Lbs\ V_n$ = (108-78) x .59 x 1458474/24 = 1,070,000

2) Heat of Absorption = ΔHabs x Mols HC = 2870 x 12346/24 = 1,990,000

3) Heat to Lean Oil = (2) − (1) = 920,000

4) Δt of Lean Oil = (3) ÷ [Lbs LO x Cp] = 920,000 ÷ 24/11,100 x 190 x 48 = 21.8°

5) Check t_i vs assumed = $t_i = t_{LO} + \Delta t$ = 81 + 21.8 = 102.8 vs 105°

L/V on Bottom Tray = $(L/V)_1$

Assume equal number mols gas absorbed each theo. tray except top.

solving for V_1, mols leaving bottom plate = $V_o - [(L_1 - L_n) / (\text{Total Trays} - 1)]$

From Sheet: V_1 = Col.5 − [(Col.15 − Col.21) / (Trays − 1)]

V_1 = 82,959-(23446-17664)/5 =

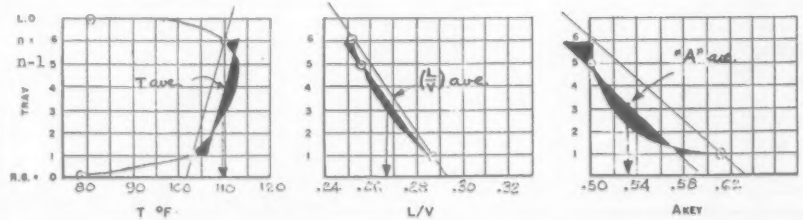
$(L/V)_1$ = 23446 / 81799 = 0.287

$(L/V)_n$ = 17664/70347 = 0.251, A_n = .251/.50 = .502

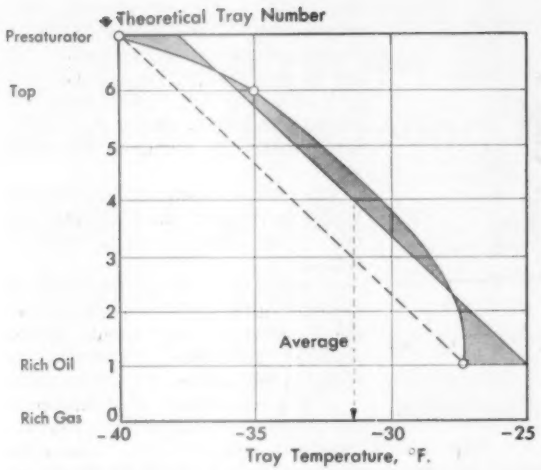
$(L/V)_{n-1}$ = 19518/76911 = 0.255, A_{n-1} = .255/.505 = .505

$(L/V)_1$ = ____, A_1 = .287/.47 = .61

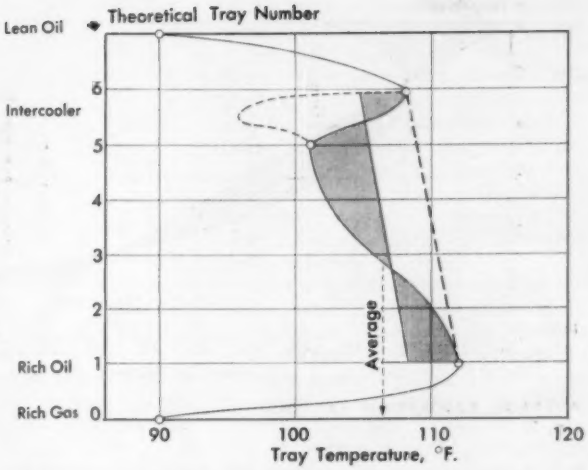
Graphical Solution For Average Absorption Factor For Key.



Final-calculation sheet A-4



TEMPERATURE PROFILE for low-temperature absorber with top presaturator chiller. Fig. 1.



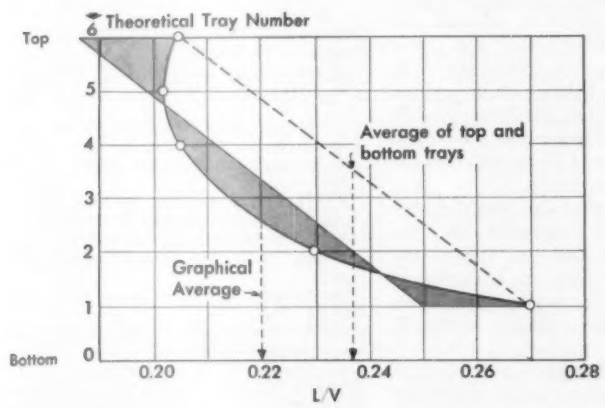
TEMPERATURE PROFILE for absorber with intercooler. Fig. 2.

rather than using total enthalpies. For specific heats of gases we use a combination of Buthod's[2] curves and experimental data of Sage et al.[9] Specific heats of liquids obtained from various sources are usually in good agreement. Maxwell[4] and TEMA are good sources. Heats of absorption are more difficult to obtain. We have used the following: Scheibel[10] average molecular weight correlation; Peter's[8] extrapolated data correcting for liquid phase mole weight; Kellogg total heat charts that appear in the 1957 NGSMA Data Book. None of these will cover the full range of temperatures and high pressures encountered in absorption calculations. We have compiled heats of absorption for each hydrocarbon component by correcting zero pressure heats-of-vaporization for pressure using reduced properties and the $\Delta H/T$ correlation of Watson[12]. The reduced temperatures and pressures were those of a natural gas containing approximately 90 mole per cent methane. Table 1 shows a comparison of the heats of absorption from the various sources mentioned above.

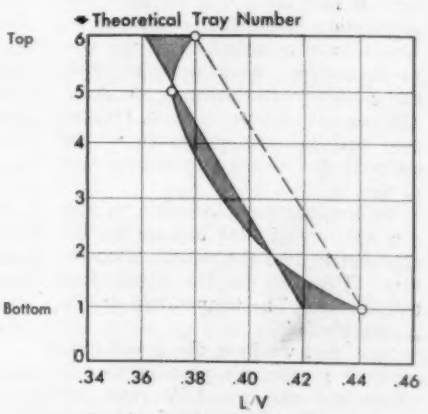
TABLE 1—Heats of Absorption, BTU per pound mole

	C_1	C_2	C_3	C_4	C_5	C_6
100° F., 500 p.s.i.a.						
NGSMA, 1957 (Kellogg)	....	3030	5240	6380	6080	....
NGSMA, 1951 (Scheibel)	1280	3440	4450	....	....	....
Peters	1005	4200	4980	....	....	....
Brown & Root	1250	3500	5100	7700	8400	9200
100° F., 1,000 p.s.i.a.						
NGSMA, 1957 (Kellogg)	....	2640	4580	....	....	....
NGSMA, 1951 (Scheibel)	1000	1560	....	....	....	....
Peters	....	....	....	....	....	....
Brown & Root	1000	2500	3800	5450	6200	7700
100° F., 2,000 p.s.i.a.						
NGSMA, 1957 (Kellogg)	....	1830	2950	....	....	....
NGSMA, 1951 (Scheibel)	....	....	....	....	....	....
Peters	....	....	....	....	....	....
Brown & Root	550	1100	2050	2900	3700	4400

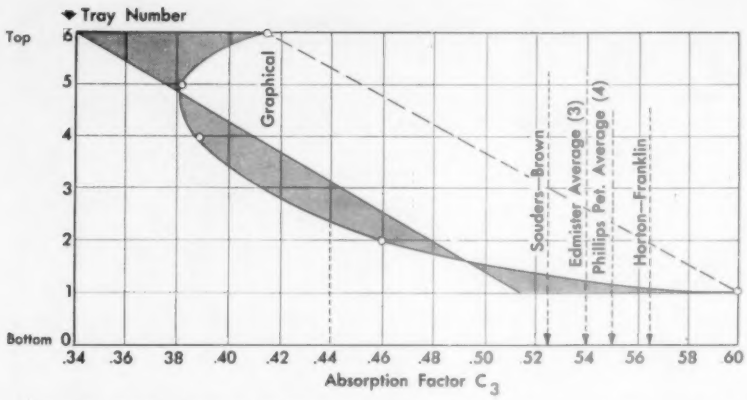
Calculation method. The sample calculation included in this article is based on a first-trial separation calculated by the Kremser[6] method as modified by Souders-Brown[11]. The assumptions made in this calculation are the average temperature at which absorption takes place and the per cent of equilibrium reached. The calculation is a rapid one when carried out on the form shown. It yields a trial oil rate and an offgas which are



LIQUID-VAPOR PROFILE of medium pressure, atmospheric temperature absorber. Fig. 3.



LIQUID-VAPOR PROFILE of intercooled absorber. Fig. 4.



AVERAGE ABSORPTION FACTORS compared by different calculation methods. Fig. 5.

the starting points for the more rigorous calculations.

The residue gas from the first-trial calculation is used to calculate the top tray of the absorber. Since the Souders-Brown empirical method usually gives a low oil rate, we arbitrarily boost the oil quantity by 10% prior to using it in the plate calculation. To calculate the top tray, one must assume the top temperature, run the dew point on the residue gas at this temperature, filling the void with absorber oil. The top temperature is checked by a heat balance around the top of the absorber assuming also a temperature of the vapor from the tray below. Note that we use sensible heat of the gas and oil and the ΔH of absorption for the mole weight of the hydrocarbon absorbed. If the calculated temperature does not check the assumed temperature, the calculation is repeated until a check is made.

After the top tray is calculated, the tray below is calculated in the same manner. The assumption of the temperature on the tray below the top tray is verified by a two-tray heat balance assuming a temperature of the vapor from the third tray from the top. It may seem that we leave one assumption unchecked; otherwise, we would have to calculate all the way to the bottom tray in order to verify our gas-temperature assumption. Actually, we can plot the lean-oil, residue-gas, and rich-gas temperatures and estimate the correct tray temperature to use.

To continue the calculation, we now run an over-all heat balance on the absorber to find the rich-oil temperature. This will be the bottom-tray temperature. The temperature profile is now plotted.

Now that we have the tower temperature profile, we proceed to calculate and plot the L/V ratio for each tray. The L/V ratio for the two top trays is obtained from the tray calculations. The bottom tray L/V is calculated by assuming that the shrinkage across the trays is equal between the bottom and the next-to-the-top tray.

The absorption factor for the key component may now be calculated using the L/V and K values obtained from the above plate calculations. Plot the absorption factor versus the plate number. The absorber average Akey is obtained by graphically averaging the plot. If the calculated average absorption factor is widely variant from the required absorption factor, the oil rate should be adjusted and the procedures repeated using previous trial temperature.

Design Features

Temperatures. The rigorous steps to arrive at the two top-plate temperatures may appear tedious; however, the need for accurate temperatures is apparent if one considers that the top temperature is the starting point for the over-all heat balance, the L/V, and the absorption-factor calculation.

A large part of the over-all heat of absorption can be removed by a chiller, thus giving the small temperature rise seen on the top tray in Fig. 1. The top temperature is selected and the chiller and separator are calculated as the top theoretical tray. To calculate a heat balance on the chiller, temperature of the gas from the absorber must be known and is obtained by calculation, and plotting the profile as described previously.

By using the design method, the location of an intercooler and the temperature of the rich oil to the intercooler can also be determined with reasonable accuracy. The effect of an intercooler is shown in Fig. 2.

Liquid and vapor rates . . . The liquid-vapor ratio profiles are as important as temperature profiles in analyzing absorber calculations. Fig. 3 is an example of L/V ratios on each theoretical tray of a medium pressure, atmospheric temperature absorber. It can be seen readily that averaging the L/V of the top and bottom trays will always result in a larger L/V than that obtained by averaging the whole tower.

The various benefits of knowing the liquid and vapor rates leaving any tray in an absorber are assessed as follows:

1. When a large gas shrinkage is expected in an absorber, knowledge of the liquid-vapor ratio speeds up the finalized absorption calculation by reducing the number of trials required.

2. For intercoolers, L/V ratio plots are hopeful in specifying the heat exchange equipment. The intercooler does not effect the L/V profile as severely as it does temperature profile (refer to Fig. 2 and Fig. 4).

Absorption factors. The plot of the absorption factor for each component versus theoretical tray number is a visual evidence of what part of the tower is most effective for that component. A typical absorption-factor profile is shown in Fig. 5 for a medium-pressure absorber. This profile was obtained from tray calculations based on performance test data. We have also plotted the average absorption factor for the key component as calculated by various published methods. In all the published methods that we compared, the calculated oil rates would be 10-20% below the actual oil rate required for the desired recovery of the key component.

We feel the outlined method for absorber design is a happy medium between a rigorous plate calculation and the shortest empirical method. The inexperienced or part-time absorption calculator should be able to design safely by this method.

Acknowledgment

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In tests made at an

Oklahoma natural-gasoline plant . . .

Transfer hose found to cause LPG contamination

BY C. W. MULLINS
Skelly Oil Co., Velma, Okla.

EVER SINCE LPG was introduced as engine fuel back in the 1930's the industry has been hounded by the problem of inefficiency, and even engine failure, caused by impurities. This contamination, in practically all instances, has been an oily residue that collects in the fuel heat exchanger (or converter) and regulators, principally in the secondary regulator. The result is sluggish operation, loss of power, poor idling, and fuel waste. In earlier days it was common practice to install regulators in an inverted position to reduce the effect of contamination.

This problem of oil infiltration has plagued the industry for so long that the marketers and manufacturers have come to accept it as an unavoidable evil, assuming it to come from excessive valve lubrication, packing oil, and compressor lubricants. Some of Skelly's Velma employes, however, found that oil was being leached out of transfer hose innerliners by LPG and left behind as the fuel vaporized.

Initial tests. In the summer of 1956, Skelly Oil Co. began a concentrated program of tests at its Velma, Okla., natural-gasoline plant, designed to pinpoint the origin of LPG oil contamination. The first step was the fabrication of test cylinders, each with a capacity of 8 gal., with an observation glass on the side, a quarter-inch needle valve in the top for venting, and a half-inch connection halfway up the vessel, for filling.

A test cylinder was installed on each product line between the storage tanks and the truck-loading dock. As each truck was loaded, a side stream of product was caught in the test cylinder set aside for that particular truck. The vent valve was then slightly opened allowing the product to evaporate slowly. These tests were continued for more than 2 years, during which time none of the test vessels contained even a trace of oil.

Locating the trouble. In August 1958 an Oklahoma industrial firm which was using LPG for fuel was experiencing excessive down time due to oil accumulations in the intake manifold and regulators of a large stationary engine. As much as a cupful of oil could be drained from the manifold each 3 to 4 days. The Velma plant personnel, after considerable trouble shooting, surmised that the oil was being extracted or leached from a half-inch hose used to transfer the liquid LPG fuel some 1,000 ft. from the storage tank to the engine. Absence of carburetion disturbance in other engines located nearer to the fuel source led to the conclusion.

A 100-ft. section of the hose was brought to the Velma plant for further research. Two of the original test cylinders were placed in the propane storage area and connected directly to a single tank, one by the half-inch hose and the other by an equal length of copper tubing. After slowly charging into and venting from each cylinder some 210 gal. of liquid, there was accumulated a heavy concentration of oil in the cylinder connected with the hose, while the cylinder with the copper hookup contained no trace of contamination.

The degree of impurity was surprising when it is considered that the hose had, previous to the test, been in service 24 hours a day for 5 months, during which time it would seem that all oil should have been rendered. Enough oil had accumulated that a sizable sample could be collected.

Testing new hose. As soon as these tests were completed, orders were placed for a length of half-inch hose with each of five major rubber-hose manufacturers. With these, identical tests were made to those performed with the customer's 100-ft. transfer hose, except that the volume of propane was held to 100, rather than 210 gal. The results were astonishing. Every hose leached a large amount of oil, but none to the same degree. As much as a pint was deposited in some of the test cylinders.

These tests, made at our Velma plant, were strictly of an observational nature. Samples were taken to our research laboratory at Pawhuska, Okla., where analyses confirmed our conclusions.

Following completion of the experiment, each hose manufacturer was given the data gleaned from tests made on his particular market product. None was surprised that the innerliner of the hose was leaching into the fuel, but all were concerned that the degree could be sufficient to produce inoperative conditions in carburetion systems.

Most hose manufacturers use an oil-impregnated neoprene compound to mold the innerliner, or tube, for LPG hose. In most instances, where an oil-resistant hose is desired, the neoprene is soaked in oil before it is molded into the innerliner. The meaning of "oil resistant" by some manufacturers is that the innerliner compound has been impregnated with a sufficient amount of oil to prevent its swelling when placed in contact with oil, or when used to transport oily products. Thus "oil-resistant" hose should never be employed in LPG service if a serviceable substitute can be used.

Even though in some respects the amount of oil extracted from hose by LPG might seem minute compared to the volume of fuel used, we must bear in mind that as LPG leaves the vaporizer and enters the carburetor in vapor state, the oil remains trapped, as a heavy liquid which accumulates on orifices and jets, and results in faulty carburetion or complete engine failure.

New type hose. The hose manufacturers were very interested in our tests and some immediately set up research programs for development of a noncontaminating hose. Two have furnished 100-ft. lengths each for testing. The one we have so far observed is not ideal but is much improved as to contamination. The other material is now under test. We have at the loading dock two 12-ft. sections of 2-in. hose, manufactured by the improved process, which we are testing for life and serviceability.

The hose-manufacturing people accepted the responsibility and are now very close to the production of a hose that will substantially reduce LPG contamination, an obstacle that has been erroneously blamed on our industry since the inception of LPG as an engine fuel.

We are pleased to have had our part in this move toward perfection in performance of liquefied petroleum gas as an engine fuel, and we look forward to improvement that will actually eliminate equipment down-time—for the farmer in the middle of irrigation or harvest, or for the industrial plant rushing to supply its market.

Presented at NGAA annual convention, Houston, 1960.

NGAA asks:

"How automated are you?"

Industry replies show extent of automation, type of equipment, and where it is used.

BY JOHN L. RYAN
Skelly Oil Co.

SINCE AUTOMATION has become an important phase of our industry, the Natural Gasoline Association of America prepared a questionnaire on automation and sent it to all association members. Its purpose was to determine the extent of automation in the natural-gasoline industry, the type of equipment in use, and the point of application.

The results showed that the unattended or partially unattended compressor station was an area of activity in which nearly all the companies were involved. Beyond this, there was considerable divergence.

Of the 34 companies reporting, only 5 reported the use of miniature instruments. Chromatographs were being used at plant level in 17 companies; however, only 9 companies are using on-stream, in-plant units; and only 3 have chromatographs operating on control. There was no mention of automatic scanning, data logging, operating guide computers, or computer control.

Other data included on the completed questionnaires indicated the existence of a small number of partially or fully automated boiler plants, dry-desiccant gas dehydrators, and product shipping and loading installations. Cooling towers also came into the picture with automatic control of temperature, makeup, pH, and chemical injection.

First Part

Tabulated here are results of the first part of the NGAA questionnaire completed by 34 member companies.

Paper presented at the NGAA Annual Convention, Houston, 1960.

NGAA Natural-Gasoline Plant

	Hours per day	Plant handling capacity: Under 20 M.M.c.f.d.	Plant handling capacity: 20 M.M.c.f.d. and above	Number companies reporting
1. How many gasoline plants do you operate:				
(a) Without any plant operator present	24	2	1	11
	22	3	2	
	16	5	1	
	8	3	0	
(b) Without any other plant employe present	24	4	4	12
	23	0	1	
	16	5	4	
	8	2	1	
(c) Without any plant employes present	24	0	0	7
	23	0	1	
	16	4	0	
	8	5	0	
2. How many compressor stations do you operate:				
(a) Without any plant operator present	24	213	4	22
	23	8	1	
	22	18	0	
	20	7	0	
	16	49	10	
	8	20	0	
(b) Without any other plant employe present	24	141	15	20
	23	8	1	
	22	30	0	
	20	7	0	
	16	26	5	
	8	18	0	
	0-2	3	0	
(c) Without any plant employe present	24	145	3	15
	23	8	1	
	22	18	0	
	20	7	0	
	16	47	3	
	8	1	0	
3. How many gasoline plants do you operate which have remote to plant contact with an employe without any plant employe present:	24	2	0	4
	16	2	1	
	8	0	0	
4. How many compressor sta-	24	7	0	8

Comment on Questions

Question No. 1. Unattended or partially unattended gasoline plants.

Note that there are no completely unattended plants reported, although a few do approach this status. Since approximately two-thirds of the partially unattended plants are in the 20-M.M.c.f.d. class, this might indicate the use of automation to make the small plant economically feasible.

Question No. 2. Unattended or partially unattended compressor stations.

Although the questionnaire did not bring out the total number of compressor stations operated, it would appear that the majority of the compressor stations under 20 M.M.c.f.d. are unattended or partially unattended. Over 300 unattended or partially unattended compressor stations are being operated by 22 companies. Of this group, pipeline-transmission com-

Automation Questionnaire

	Hours per day	Plant handling capacity: Under 20 M.M.c.f.d.	Plant handling capacity: 20 M.M.c.f.d. and above	Number companies reporting
tions do you operate which	22	7	0	
have remote to plant contact	16	7	1	
with an employe without any	8	0	0	
plant employe present:	0-2	3	0	
5. How many gasoline plants or compressor stations do you operate that have no employes present during periods of each day in which the following have been installed to provide warning or shutdown:				
(a) Fire detection				
1. Warning		55	1	6
2. Shutdown		73	4	
(b) Explosive atmosphere				
1. Warning		0	2	1
2. Shutdown		0	0	

6. Have computer programs been developed and put in regular use in your company gasoline plant operations for any of the following items? (Twenty companies reporting).

	Yes
1. Lease payment for gas	16
2. Plant monthly and annual earnings statements	10
3. Budget forecasts	5
4. New plant construction economics, profitability index	4
5. Job order control accounting	4
6. Plant investment accounting	10
7. Maintenance records and schedules	2
8. Plant operating reports	2
9. Spare parts and inventory controls	3
10. Design and evaluation of liquid extraction units	8
11. Design and evaluation of distillation and fractionation units	8
12. Design and evaluation of pipeline systems	6
13. Plant material and heat balances	4
14. Gas volume calculations	12
15. Flash calculations	1
16. Gas purchase statement	1
17. Tower foundation design	1
18. Tank strapping tables	1
19. Time and payroll	1
20. Gas analysis	1
21. Compressor loading calculations	1
22. Absorber tray-to-tray calculations	1
23. Design and evaluation of compressor plants	1

panies account for 35% of the stations.

Questions No. 3 and No. 4. Remote to plant contact.

Only 5 such gasoline plants have been reported in this category, but this is a large percentage of the partially unattended gasoline plants reported. This might indicate the need for surveillance of the unattended plant. This is not the case with compressor stations since only 25 stations out of over 300 have such surveillance.

Question No. 5. Fire and explosive-atmosphere Detection.

Most of the installations using fire-detection equipment completely unattended compressor stations. Two of the six companies reporting apparently have standardized on this type of equipment and account for 80% of the installations.

Question No. 6. Computer programs.

Note that many of the listed programs can be handled by either business machines or computers. The questionnaire did not bring out the type of equipment in use.

Second Part

Data from the second part of the NGAA questionnaire dealing with gasoline plants, method of control, type of equipment used, and the extent of automation are tabulated below. Due to the volume of material involved, it was necessary to summarize this information.

Gasoline plants under 20 M.M.c.f.d. From the total of 34 reports, 21 companies reported plants in this category.

In reviewing this tabulation, we must realize that we are dealing with small plants, many of which have been in existence for 10 to 20 years.

Control instrumentation is almost exclusively conventional pneumatic, and probably most of the instruments are locally mounted. A number of on-stream chromatographs were reported, and four units are on automatic control.

In general, almost all startup operations are manual. Safety devices and shutdown equipment are the standard items that have been in use for many years.

Gasoline plants over 20 M.M.c.f.d. Of the companies reporting, 27 have reported plants with capacities exceeding 20 M.M.c.f.d. Accompanying is a summary of those plants.

In the over 20 M.M.c.f.d. classification, conventional pneumatic control systems are again predominant. However, a greater percentage of miniature instruments were reported. Since the larger plant normally occupies a greater area, one would expect a greater use of the transmission-type control system and a central control room.

Over-all, the use of the chromatograph appears to be about the same in the large plant as in the small plant, except that the onstream unit is used more frequently. The large plants have in operation a wider variety of composition analyzers in far greater numbers. Onstream analyzers are more predominant in the large plant.

Gas-compressor facilities. This section was omitted from the tabulations on natural-gasoline plants since most companies grouped gasoline plant compressors and compressor stations. An accompanying tabulation includes all compressor installations reported.

Of the almost 500 compressor installations reported, over 163 are on auto-

Breakdown of replies to automation questionnaire

. . . plants with capacity under 20 M.M.c.f.d.

	Control equipment							Composition analyzers									Number
		Miniature		Conventional													
	Manual	Pneu.	Elect.	Pneu.	Elect.	Proc. analyz.	On stream analyz.	LTD	Mass spec.	Infra-red	Chro-mato-graph	Gravi-tom-eter	Calo-rim-eter	Mois-ture monitor	H_2S Ana-lyzer	IBP & EP recorders	Com-panies reporting
LIQUID PRODUCT EXTRACTION																	
Absorption	..	..	..	53	..	..	3	9	..	..	6	..	..	..	..	..	19
Adsorption	..	..	..	4	..	..	..	2	..	..	..	..	..	..	..	..	2
Refrigeration	1	1	..	12	..	..	..	..	..	..	..	..	..	..	..	..	11
FRACTIONATION																	
Deethanizer	..	..	2	38	..	..	1	5	..	..	13	..	..	..	..	..	17
Depropanizer	..	..	..	40	..	3	1	7	..	..	[3]13	..	..	..	..	..	17
Deisobutanizer	..	..	..	7	..	..	1	1	..	..	3	..	..	..	..	..	4
Debutanizer	..	..	..	52	..	1	1	6	..	..	[1]3	..	..	..	..	..	16
GAS TREATING, DEHY. & SWEETENING																	16
Dry desiccant	13	..	..	7	2	..	..	..	..	..	..	..	..	..	..	..	..
Glycol	3	..	..	4	..	..	..	..	..	..	..	4	..	..	..	..	..
Sulfur removal	9	..	..	1	..	..	..	..	..	..	..	..	..	..	3	..	..
PRODUCT TREATING, STORAGE, DISPOSITION																	
Sulfur removal	25	..	..	13	..	..	..	..	..	..	..	..	..	..	..	..	14
Dehydration	12	..	..	7	..	..	..	..	..	..	..	..	..	..	..	..	11
Product storage	64	..	..	..	..	..	1	4	..	..	1	..	..	..	..	..	20
Product shipping	58	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	21
UTILITIES & AUX.																	
Boiler	15	..	..	36	.. (Pressure control)			..	..	..	..	..	..	..	..	..	17
Direct fired heater	2	..	2	36	1 (Temp. control)			..	..	..	..	..	..	..	..	..	18
Electric generator	30	..	..	..	2 (Startup)			..	..	..	..	..	..	..	..	..	14
Cooling water system	75	..	..	7	.. (Temp. control)			..	..	..	..	..	..	..	..	..	19
Plant air supply	1	..	..	41	76 (Pressure control)			..	..	..	..	..	..	..	..	..	20
Plant air dehydration	22	..	..	7	16 (Cycle control)			..	..	..	..	..	..	..	..	..	20

Superscript indicates the analyzer and number on control.

. . . plants with capacity over 20 M.M.c.f.d.

	Control equipment							Composition analyzers									Number
		Miniature		Conventional													
	Manual	Pneu.	Elect.	Pneu.	Elect.	Proc. analyz.	On stream analyz.	LTD	Mass spec.	Infra-red	Chro-mato-graph	Gravi-tom-eter	Calo-rim-eter	Mois-ture monitor	H_2S Ana-lyzer	IBP & EP recorders	Com-panies reporting
LIQUID PRODUCT EXTRACTION																	
Absorption	..	9	..	111	..	..	3	2	..	..	6	..	..	..	..	..	26
Adsorption	..	..	2	7	..	..	..	..	..	..	..	..	..	..	..	..	6
Refrigeration	.	3	..	22	..	..	2	1	..	..	4	..	..	..	..	..	17
FRACTIONATION																	
Deethanizer	..	8	..	82	..	2	2	19	..	..	[2]11	..	..	..	..	2	23
Depropanizer	..	10	..	67	..	1	4	10	..	1	[1]20	..	..	..	..	2	26
Deisobutanizer	..	6	..	17	..	1	8	2	..	1	[1] 9	..	..	..	..	..	16
Debutanizer	2	3	15	50	..	2	4	23	1	1	[1]18	..	..	..	..	[1]2	26
GAS TREATING, DEHY. & SWEETENING																	22
Dry desiccant	50	..	..	22	1	..	45	..	..	..	3	20	19	3	..	..	..
Glycol	2	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..
Sulfur removal	66	..	..	1	..	..	12	..	..	..	..	..	..	..	12	..	..
PRODUCT TREATING, STORAGE, DISPOSITION																	
Sulfur removal	42	..	..	9	..	..	..	..	..	..	..	..	..	..	..	..	14
Dehydration	41	..	..	8	..	..	..	..	..	..	..	..	..	..	..	..	20
Product storage	99	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	26
Product shipping	100	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	27
UTILITIES & AUX.																	
Boiler	3	2	1	114	2 (Pressure control)			..	..	..	..	..	..	..	..	..	25
Direct fired heater	..	5	..	92	4 (Temp. control)			..	..	..	..	..	..	..	..	..	25
Electric generator	133	..	..	..	4 (Startup)			..	..	..	..	..	..	..	..	..	22
Cooling water system	173	..	..	12	.. (Temp. control)			..	..	..	..	..	..	..	..	..	26
Plant air supply	1	..	..	103	107 (Press. control)			..	..	..	..	..	..	..	..	..	27
Plant air dehydration	54	..	..	18	62 (Cycle control)			..	..	..	..	..	..	..	..	..	27

Superscript indicates analyzer and number on control.

What was learned about compressor installation

GAS COMPRESSOR FACILITIES	PLANT VARIABLE CONTROLLED BY: Manual	Miniature: Pneumatic	Miniature: Elect.	Conventional: Pneumatic	Conventional: Elect.	Other
Startup and shutdown	479	0	0	7	4	0
Unloading and loading	463	0	0	15	2	0
Load speed	234	0	0	159	4	32
Lube-oil makeup	331	0	0	56	0	60
Cooling-water makeup	329	0	0	138	0	32
Cooling-water temperature	64	0	0	296	91	63
Emergency shutdown	74	0	0	152	333	0
High cooling-water temperature	18	0	0	150	336	0
Low oil pressure	8	0	0	225	279	0
Overspeed	61	0	1	26	312	19
Vibration	91	0	0	0	64	3
High Temperature discharge	0	0	0	0	19	0
High discharge pressure	0	0	0	6	99	0
Low discharge pressure	0	0	0	0	9	0

matic load-speed control. We would assume that the majority of these load-control devices are used on compressor stations rather than natural-gasoline-plant compressors.

Note the number of automatic lube-oil and cooling-water makeup controls—a "must" for the completely unattended station.

Cooling-water temperature controls have been reported on almost all installations. Undoubtedly, this reflects the common usage of an individual temperature regulator for each engine rather than the control of a multiengine cooling system.

The majority of the high-discharge-temperature shutdowns are probably on compressors operating with dry compressor cylinder jackets.

From the data received in questionnaires, it may be concluded that the majority of the companies in the natural-gasoline industry are actively engaged in automation to some extent.

BOOKS

PRINCIPLES OF UNIT OPERATIONS. By A. S. Foust, L. A. Wenzel, C. W. Clump, L. Maus, and L. B. Anderson. Published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16. 578 pp. $15.

The traditional unit-operations concept has been a major factor in the phenomenal success of chemical engineers and chemical engineering in the last 50 years. This book, however, breaks away from the traditional treatment and offers a new approach that is more economical in time.

The unit operations are presented as unifield groups of operations stemming from identical fundamentals. The developments are built up from a simplified physical model or a basic mathematical relation, or both, using generalized notation.

After a thorough coverage of the simplified models, the treatment progresses to the more complicated handling of realistic problems by applying the general equations to the specific operations. Emphasis is always placed on the general principles underlying groups of operations, and attempt is made not to obscure the fundamentals of the processing operation by the use of elaborate mathematics that is necessary for rigorous solution of complex problems.

CHEMICAL TECHNOLOGY OF PETROLEUM. By W. A. Gruse and D. R. Stevens. Published by McGraw Hill Book Co., Inc., 327 W. Forty-first Street, New York 36. 800 pp. $15.

This newly published third edition completely covers the chemistry of petroleum and the modern methods, standards, and practices of petroleum distilling and refining. The book supplies a chemical introduction to the science and technology of petroleum.

Chemical constituents of petroleum; physical properties and common characteristics of the various types; and origins, production processes, uses, products, and byproducts are all analytically and authoritatively discussed.

The book explains the recent applications of thermodynamics in solving problems of hydrocarbon chemistry and the production and uses of derived byproducts. There is also a detailed description of the important types of petroleum and a critical comparison of the various methods of refining and distilling.

Among the many subjects covered are production, classification and description of crude oils; composition of petroleum and petroleum products; motor fuels; kerosine; absorbent oils and fuel oils; lubrication and lubricants; and petroleum waxes and asphalts.

Nelson Refinery Cost Indexes

Published in the first issue each month in the Technology-Operating Section.

Compiled by W. L. Nelson, Technical Editor and petroleum refinery consultant, Tulsa.

Charts of the indexes are published each year in a late January or early February issue.

Indexes of selected individual items of equipment and materials are also published on the Costimating page in the first issue of the months of January, April, July, and October.

Refinery Construction Cost Index (1946 Basis)

Explained on page 101 of the issue of August 5, 1957.

	1950	1954	1957	1958	1959	Dec. 1959
Pumps, compressors, etc.	138.2	166.5	206.7	214.7	226.5	227.3
Electrical machinery	134.9	160.0	188.9	192.7	195.8	197.7
Internal-combustion engines	126.0	150.5	173.9	178.3	178.5	177.9
Instruments	127.8	154.6	187.4	194.9	201.0	198.6
Heat exchangers	140.0	171.7	203.6	181.2	178.9	192.1
Misc. equipment average	*126.2	160.7	192.1	192.4	196.1	198.7
Materials component	149.5	174.6	201.9	204.2	207.8	208.9
Labor component	144.0	183.3	208.6	220.4	231.6	236.6
Nelson construction index	146.2	179.8	205.9	213.9	222.1	225.5

*Used in computing the Nelson Index until April 1952.

Refinery Operating Cost Indexes (1956 Basis)

Explained on page 171 of the issue of June 1, 1959.

	1946	1952	1954	1957	1958	Nov. 1959
Fuel cost	49.6	81.0	86.5	*115.1	*102.1	103.7
Labor cost	73.1	88.7	90.9	106.1	105.0	103.8
Wages	52.4	81.5	88.7	104.1	105.4	114.1
Productivity	68.3	90.2	97.1	98.1	100.3	110.0
Investment, maintenance, etc.	51.2	83.6	92.0	105.4	109.5	115.5
Chemicals cost	37.0	72.1	85.7	102.2	104.4	116.3
Operating cost indexes:						
Refinery	58.5	80.5	88.7	*106.7	*105.8	109.2
Process units†	62.9	82.2	88.4	*107.7	105.8	107.3

*Revised. †Add separate index for chemicals, if any are used.

Where gaps still exist in

ENTHALPY DATA

NEW THERMAL DATA are available on pure light hydrocarbons and mixtures of these materials. Here is a resume of compounds and mixtures which have been investigated and the extent to which they have been studied.

Pure hydrocarbons. The thermal data available on the straight-chain paraffin hydrocarbons are summarized by Baker[1] in Figs. 1 and 2. Study of these figures shows that a reasonable amount of thermal data has been obtained for some, but not all, of these lighter paraffins.

Hydrocarbon mixtures. The thermal data on hydrocarbon mixtures are extremely limited. It is interesting to note that only one investigation, that of Nelson and Holcomb[10], has been carried out recently. A good portion of the "thermal" data on mixtures has been obtained by Joule-Thomson measurements. The situation on hydrocarbon mixtures is graphically summarized in Fig. 3, also prepared by Baker.

In 1945 Scheibel and Jenny[15] proposed one of the earlier methods for estimating enthalpy values of hydrocarbon mixtures. Their method is based on the assumption that a pure hydrocarbon and a hydrocarbon mixture of the same molecular weight and at the same conditions of temperature and pressure will have identical enthalpies. This is the so-called "equivalent component concept." The authors presented their results in the form of a nomogram.

Maxwell[9] later proposed that the equivalent component concept be applied to the vapor phase, but that the enthalpy of the liquid phase be treated as an additive property.

Partial enthalpies. Numerous attempts have been made to estimate partial enthalpy values and with these calculate the enthalpies of mixtures.

To illustrate the difficulty of estimating partial enthalpies, plots of partial enthalpies for equimolal mixtures of methane-ethane are included as Figs. 4 and 5. These data have been presented by Sage and Lacey.[13]

Papadopoulos, Pigford, and Friend,[11] and Edmister and Canjar[6] have presented partial enthalpy values for the light hydrocarbons. In both cases the partial enthalpy was defined as the difference between the enthalpy of the substance in the ideal gas state at a given temperature and the enthalpy of the substance in a given mixture at the same temperature but the pressure of system.

Peters[12] presented a set of partial enthalpy values for light hydrocarbons. These were obtained by applying the relationship:

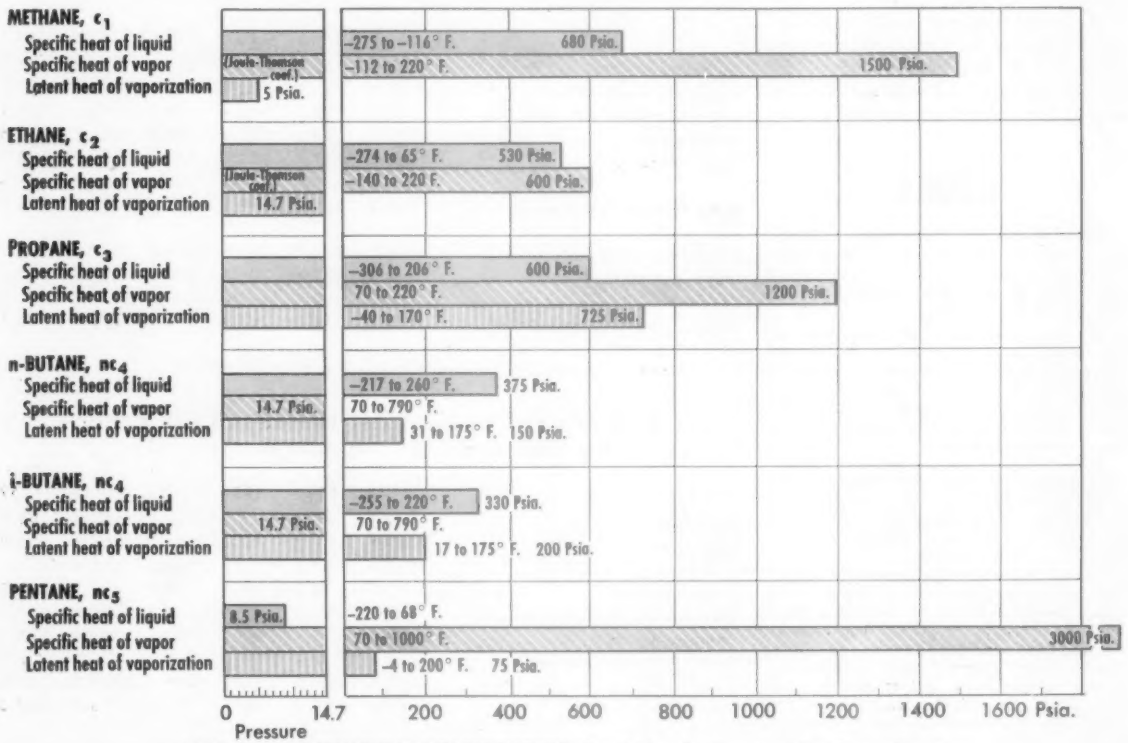
$$\ln (K'_b/K'_d) = (\Delta H_p/R)\,[(1/T_b) - (1/T_d)] \quad (1)$$

Edmister[7] proposed a modified form of Equation 1 be used to determine integral isobaric heats of vaporization. This equation was:

$$H_p = \Sigma z_i \left(\frac{RT_bT_d}{T_d - T_b} \ln \frac{K'_d}{K'_b}\right) + \Sigma z_i \Delta H_i^0 \quad (2)$$

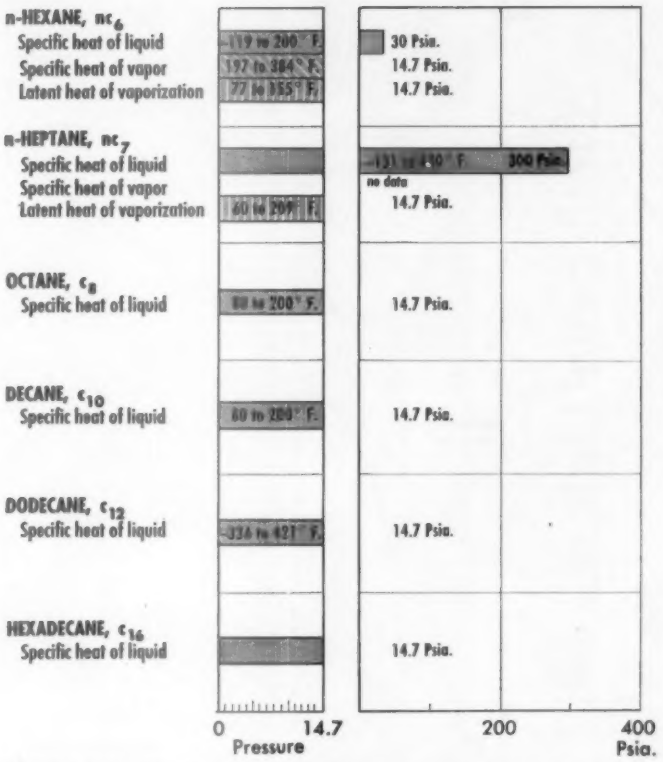
Canjar and Peterka[4] proposed that the equivalent component concept be applied to partial enthalpies. They also used the molal average boiling point rather than the average molecular weight as their basis.

Stiehl, Hobson, and Weber[16] calculated differential heats of conden-



RANGE OF EXPERIMENTAL MEASUREMENTS of enthalpy for pure hydrocarbons. Fig. 1.

Abridged from a paper given by Dr. James H. Weber, University of Nebraska, at the NGAA annual convention, Houston, 1960.



RANGE OF EXPERIMENTAL MEASUREMENTS of enthalpy for pure hydrocarbons. Fig. 2.

sation and from these, vapor-phase volumetric and enthalpy, and vapor-liquid equilibrium data determined liquid-phase enthalpies for a number of binary systems. The basic equations involved are given by Dodge.[5]

Comparison of methods. To show how the results obtained by some of the methods discussed compare, isobaric integral latent heats were calculated for two systems at various conditions of pressure and composition. The results are presented in

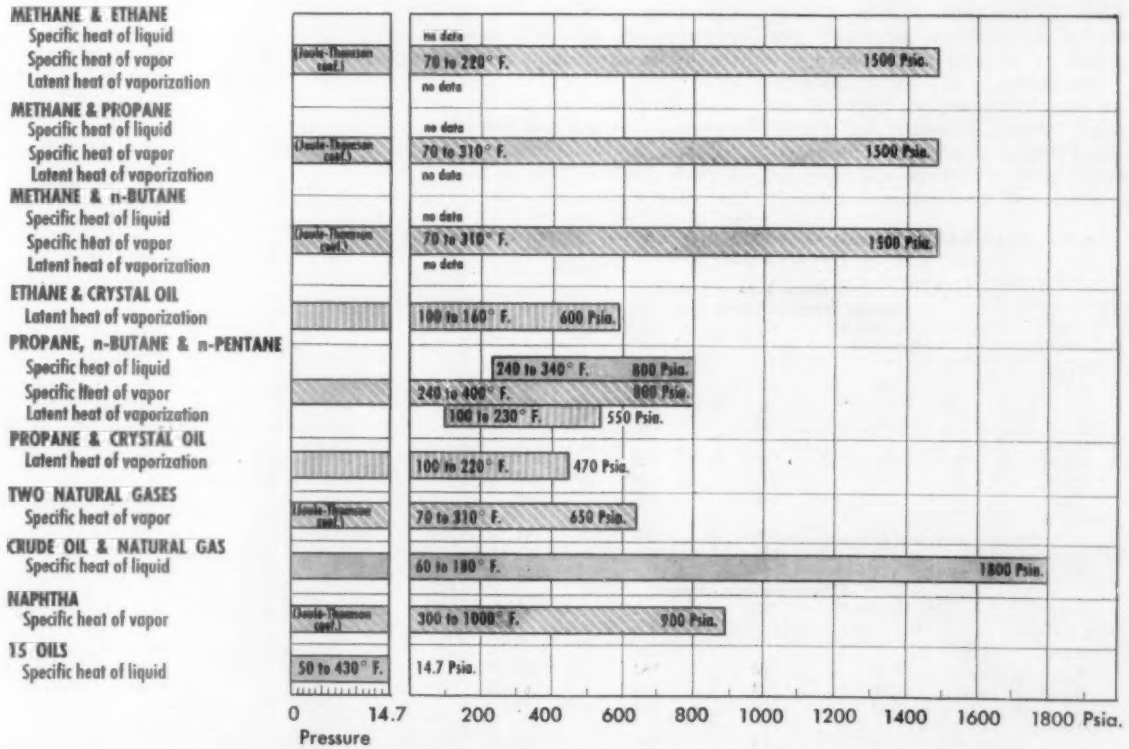
NOMENCLATURE

Note: Any consistent set of units may be used.

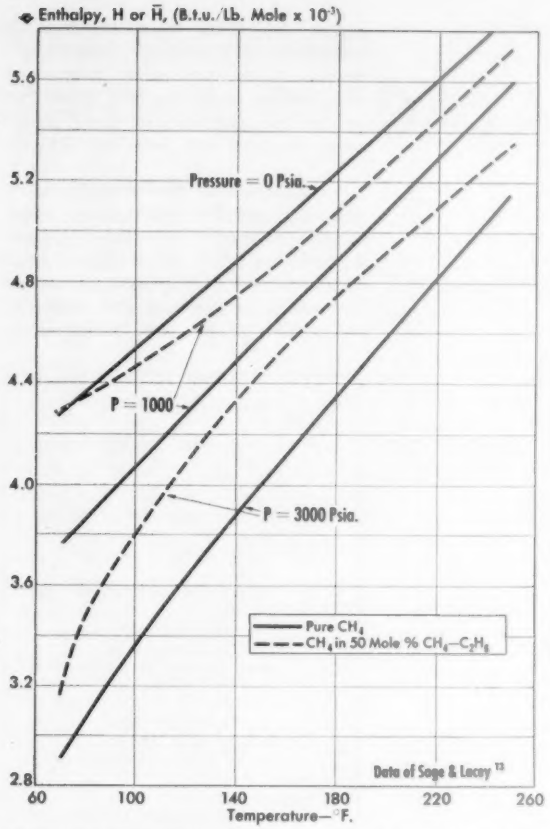
H = enthalpy
$\mathbf{H}$ = partial enthalpy
ΔH_v = isobaric integral heat of condensation
$\Delta \mathbf{H}_v$ = partial isobaric heat of condensation
K' = equilibrium vaporization ratio
P = pressure
R = gas law constant
T = absolute temperature
z = mole fraction of a component in either phase

Subscripts:
b refers to bubble point
d refers to dew point
i refers to "i^{th}" component in a mixture

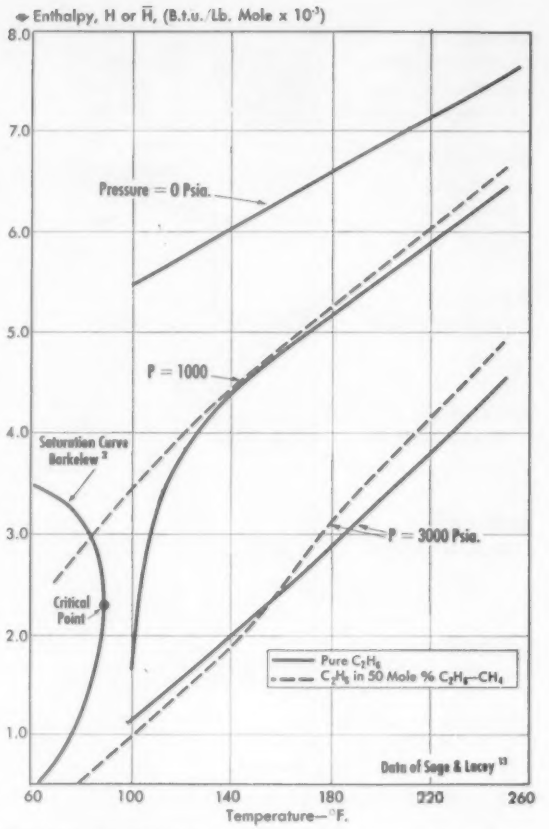
Superscript:
° refers to property in ideal gas state



RANGE OF EXPERIMENTAL MEASUREMENTS of enthalpy for mixtures of hydrocarbons. Fig. 3.



ENTHALPY OF METHANE in equimolal mixtures of methane-ethane. Fig. 4.



ENTHALPY OF ETHANE in equimolal mixtures of methane-ethane. Fig. 5.

Table 1. This table includes a number of comparisons previously presented by Hobson and Weber.[8]

The ability of any one of the present correlation methods (Scheibel and Jenny, Peters, Edmister, and Canjar and Peterka) to predict accurate enthalpy data at extreme conditions of pressure and temperature is certainly opened to question. Only additional experimental data will show clearly the degree of reliability of these methods.

At the present no one can say with certainty that any one method is better than any other method and that a given method gives an average error of a specific per cent.

TABLE 1—ISOBARIC INTEGRAL LATENT HEATS OF VAPORIZATION BY VARIOUS METHODS

Methane-Ethane System
Isobaric Integral Latent Heat, Btu/Lb.

Comp. Mole Fr. C_1	S., H., and W., Ref. (16)	E., Ref. (7)	C. and P., Ref. (4)	P., Ref. (12)	M., Ref. (9)
200 psia.					
0.2	199	192	207	202	194
0.5	245	210	238	222	229
0.7	247	218	242	219	224
400 psia.					
0.2	171	156	152	171	174
0.5	217	178	196	192	186
0.7	220	178	200	189	245
600 psia.					
0.2	125	138	95	144	158
0.5	172	131	138	163	170
0.7	175	136	...	161	158

Ethane-n-Butane System

Comp. Mole Fr. C_2	S., H., and W., Ref. (16)	E., Ref. (7)	C. and P., Ref. (4)	S. and J., Ref. (15)	M., Ref. (9)
200 psia.					
0.2	155	160	162	161	156
0.5	191	194	188	187	192
0.7	195	185	188	192	192
400 psia.					
0.2	129	119	123	124	101
0.5	173	147	150	158	148
0.7	176	121	156	162	161

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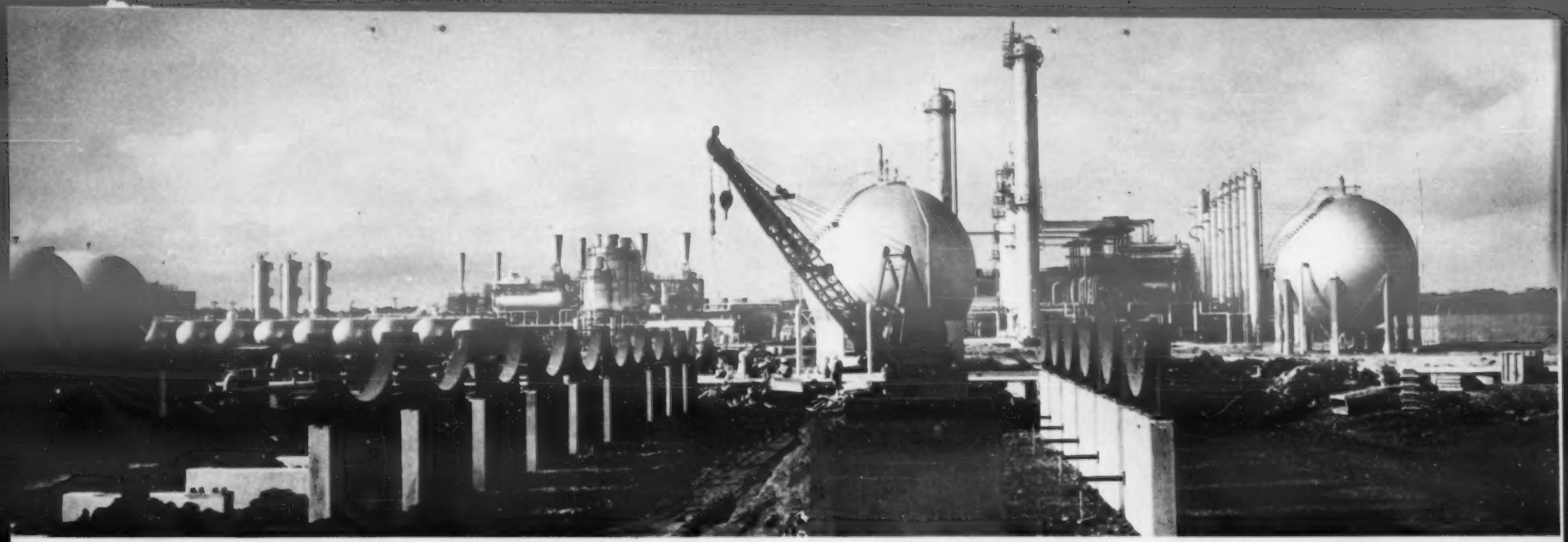


EXPANSION at Pan American Petroleum Corp.'s field-processing plant at Old Ocean field, Texas, will increase capacity from present 350 M.M.c.f. to 570 M.M.c.f. daily.

Journal Survey of Natural-Gasoline Plants in the United States

State Capacities as of January 1, 1960, and Average Production in 1959

State—	No. plants	M.M.c.f. Daily Capacity	M.M.c.f. Daily Throughput	Production—Gallons Daily Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other	Total Products
Arkansas	5	376.9	120.9	94,788	18,000	21,088	26,200		56,400	10,799	227,275
California	54	1,808	1,275.7	759,919	61,437	115,282	217,112	159,470	2,280,444		3,593,664
Colorado	13	504	313	169,130		83,500	30,000	40,530	113,960		437,120
Illinois	5	576.1	544.7	562,242		65,000	112,865		75,351		815,458
Kansas	13	1,830	1,504	135,260	29,464	143,306	10,686	54,000	283,363		656,079
Kentucky	6	1,131.2	921.1				365,000	1,270	64,000		430,270
Louisiana	38	3,711.4	3,117.7	645,444	176,903	200,863	193,952	172,513	551,506	220,415	2,161,596
Michigan	1	12	5				6,000				6,000
Mississippi	2	50	44.5	4,500			5,300		18,200		28,000
Montana	2	66	28.2	30,400		10,000	7,300		13,500		61,200
Nebraska	5	68.5	62	65,395		26,907			36,950		129,252
New Mexico	26	2,449.4	1,983.5	645,135	27,500	539,556	216,257	837,459	677,018	14,477	2,957,402
North Dakota	1	65	41	84,000		50,000			30,000		164,000
Oklahoma	67	2,426.4	2,028.8	975,322	66,004	272,453	346,674	967,281	957,609		3,585,343
Pennsylvania	4	21	15	3,500		2,000			3,485		8,985
Texas	211	14,263.3	11,436.5	3,464,749	465,566	1,846,469	1,292,786	7,064,326	4,222,490	587,872	18,944,258
Utah	2	172	90						420		420
West Virginia	36	564.8	344.6	44,520	1,000	42,301	37,000	204,200	62,950		391,971
Wyoming	11	539.5	346.5	160,446	6,000	77,554	100	83,600	74,901		402,601
Total	501	30,635.5	24,222.7	7,844,750	851,874	3,496,279	2,867,232	9,584,649	9,522,547	833,563	35,000,894

Plant Capacities January 1, 1960, and Average Production in 1959

Products listed in the last column are identified by numbers:

1. Ethane
2. Ethane mix
3. Isopentane
4. Normal pentane
5. Upgraded motor fuel
6. Solvent naphtha
7. Jet fuel
8. Diesel
9. Kerosine
10. Light residuum
11. Diesel, kerosine, and bottoms

NR means not reported.

Company, Plant, and Location	Nearest Town	M.M.c.f. daily		Gas Process Method	Production—Gallons Daily						
		Capacity	Throughput		Propane	Isobutane	Normal Butane	LPG-Mix	Combined Gaso.-LPG	Natural Gasoline	Other
Arkansas											
Arkansas Louisiana Chemical Corp.											
Various fields, Columbia County	Magnolia	350.0	105.0	Abs.	85,500	18,000	15,800	.....	.....	13,900	*7,600
Mobil Oil Co.											
Kenova plant, Smackover field, Union County	Smackover	3.0	2.0	Abs.	.....	.....	.....	2,200	.....	6,500	.....
Querbes Oil Co., J. R.											
Helwig plant, South field, Union County	El Dorado	2.0	1.0	Abs.	.....	.....	.....	.....	.....	5,000	.....
Shell Oil Co.											
Magnolia field, Columbia County	Magnolia	20.0	11.0	Abs.	6,000	.....	.....	24,000	.....	31,000	.....
Sunray Mid-Continent Oil Co.											
Midway field, Lafayette County	Lewisville	NR	1.9	Abs.	3,288	.....	5,288	.....	.....	.....	*3,199
Total		376.9	120.9		94,788	18,000	21,088	26,200	.....	56,400	10,799
California											
Brea Canon Oil Co.											
Brea field	.....	NR	NR	NR	.....	.....	.....	15,000	.....	.....	.....
Coline Gasoline Corp.											
Rincon-Padre field, Ventura County	Ventura	20.0	14.0	Abs.	22,000	.....	10,000	.....	.....	15,000	.....
Continental Oil Co.											
San Miguelito field, Ventura County	Ventura	25.0	20.2	Abs.	27,510	.....	.....	.....	36,170	.....	.....
Honolulu Oil Corp.											
Buena Vista Hills field, Kern County	Taft	16.0	13.0	Abs.	39,676	.....	.....	.....	.....	190,508	CO_2 (65 tons)
Cymric field, Kern County	McKittrick	40.0	11.0	Abs.	70,219	.....	.....	63,656	.....	284,224	.....
Inglewood Gasoline Co.											
Potrero field, Los Angeles County	Inglewood	10.0	8.0	Abs.	.....	.....	.....	3,456	.....	8,200	.....
Lomita Gasoline Co.											
Long Beach field, Los Angeles County	Long Beach	63.0	23.0	Abs.	.....	.....	.....	12,000	.....	84,000	.....
Magruder, P. S.											
Western plant, Kettleman Hills field, Kings County	Avenal	65.0	40.0	Abs.	19,000	5,000	2,000	.....	.....	30,000	.....
Huffman plant, Kettleman Hills field, Fresno County	Avenal	50.0	40.0	Abs.	29,000	8,000	13,000	.....	.....	25,000	.....
Mobil Oil Co.											
Helm field, Fresno County	Burrel	25.0	7.4	Abs.	5,200	.....	2,700	.....	.....	6,600	.....

*Type not reported.

Company, Plant, and Location	Nearest Town	M.M.c.f. daily		Gas	Production—Gallons Daily						
		Capacity	Throughput	Process Method	Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
CALIFORNIA (Continued)											
Santa Fe Springs field, Los Angeles County	Santa Fe Spgs.	24.0	5.9	Abs.	.....	.....	.....	.....	.....	49,400	.....
Ventura Avenue field, Ventura County	Ventura	15.0	4.9	Abs.	.....	.....	.....	.....	.....	11,100	.....
Wilmington field, Los Angeles County	Wilmington	50.0	25.7	Abs.	.....	.....	.....	.....	.....	146,500	.....
Monterey Oil Co.											
Huntington Beach field, Orange County	Huntington Beach	12.0	2.7	Abs.	2,108	.....	.....	.....	.....	19,977	.....
Rice Ranch Oil Co.											
Santa Barbara County (shut down)	.....	...	...	....	.....	.....	.....	.....	.....	.....	.....
Richfield Oil Corp.											
East Los Angeles field, Los Angeles County	Los Angeles	4.0	3.0	Refr.	.....	.....	.....	.....	.....	4,000	.....
North Coles Levee field, Kern County	Tupman	160.0	165.0	Abs. & Refr.	47,000	.....	.....	.....	.....	119,000	.....
Russell Ranch field, San Luis Obispo County	Cuyama	18.0	15.0	Abs.	11,000	.....	11,000	.....	.....	18,000	.....
South Cuyama field, Santa Barbara County	Cuyama	80.0	78.0	Abs.	43,000	13,000	16,000	.....	.....	44,000	.....
Shell Oil Co.											
Brea-Olinda field, Los Angeles County	Brea	25.0	10.0	Abs.	.....	.....	.....	.....	.....	47,000	.....
Signal Hill field, Los Angeles County	Long Beach	8.0	4.0	Abs.	.....	.....	.....	.....	.....	32,000	.....
Ten Section field, Kern County*	Bakersfield	65.0	40.0	Abs.	52,000	9,000	17,000	.....	.....	32,000	.....
Ventura Avenue field, Ventura County	Ventura	147.0	112.0	Abs.	75,000	.....	.....	.....	.....	270,000	.....
Signal Oil & Gas Co.											
Plant No. 2, Signal Hill-Wilmington field, Los Angeles County	Long Beach	40.0	17.0	Abs.	10,000	.....	.....	.....	.....	37,000	.....
Plant No. 10, Ellwood field, Santa Barbara County	Goleta	15.0	3.3	Abs.	1,200	.....	.....	.....	.....	5,000	.....
Plant No. 11, Huntington Beach field, Orange County	Huntington Beach	50.0	34.0	Abs.	25,000	.....	.....	.....	.....	100,000	.....
Plant No. 18, Maricopa field, Kern County	.....	10.0	4.6	Abs.	.....	.....	.....	.....	7,600	.....	.....
Standard Oil Co. of California, Western Operations, Inc.											
Colonia Vapor plant, Ventura County	Oxnard	1.0	1.0	Comp.	.....	.....	.....	.....	.....	6,500	.....
Greeley field, Kern County*	Bakersfield	25.0	23.0	....	20,000	.....	.....	12,000	.....	18,000	.....
Huntington Beach field, Orange County	Huntington Beach	15.0	9.0	Abs.	5,300	.....	.....	.....	.....	29,200	.....
Inglewood field, Los Angeles County	Inglewood	15.0	10.0	Abs.	.....	.....	.....	.....	19,700	.....	.....
Kettleman Hills field, Kings and Fresno counties*	Avenal	140.0	76.0	Abs.	30,000	8,000	3,000	12,000	.....	57,000	.....
Lost Hills field, Kern County	Bakersfield	3.5	3.0	NR	.....	.....	.....	.....	2,700	.....	.....
Midway field, Kern County	Taft	52.0	50.0	Abs.	17,000	.....	.....	.....	.....	73,900	.....
Mountain View field, Kern County	Bakersfield	17.0	10.0	Abs.	.....	.....	.....	.....	.....	17,400	.....
Murphy Coyote field, Orange County*	La Habra	50.0	35.0	Abs.	10,600	.....	.....	.....	.....	42,700	.....
Naval Petroleum Reserve No. 1, Elk Hills field, Kern County	Tupman	4.0	3.0	Abs.	.....	.....	.....	.....	.....	2,400	.....
Northeast Coalinga field, Fresno County	Coalinga	40.0	2.5	Comp.	.....	.....	.....	.....	.....	2,900	.....
Santa Fe Springs field, Los Angeles County	Santa Fe Spgs.	5.0	2.0	Abs.	.....	.....	.....	.....	.....	13,300	.....
Seal Beach field, Orange County	Seal Beach	22.0	17.0	Abs.	.....	.....	.....	.....	40,400	.....	.....
Torrance field, Los Angeles County	Torrance	6.0	4.0	Abs.	.....	.....	.....	.....	.....	8,400	.....
Sunray Mid-Continent Oil Co.											
Newhall plant, Los Angeles County	Newhall	40.0	50.0	Abs.	28,000	.....	11,000	.....	.....	21,000	.....
Superior Oil Co.											
Rio Bravo field, Kern County	Shafter	30.0	22.0	Abs.	33,406	5,337	17,282	.....	.....	18,235	.....
Texaco Inc.†											
Honor Rancho plant, Los Angeles County	Castaic	18.0	NR	Abs.	.....	.....	.....	28,000	.....	16,000	.....
Santa Fe Springs plant, Los Angeles County	Santa Fe Spgs.	12	NR	Abs.	.....	.....	.....	4,000	.....	35,000	.....
Shiells Canyon plant, Ventura County	Fillmore	32.0	NR	Abs.	.....	.....	.....	35,000	.....	33,000	.....
Signal Hill plant, Los Angeles County	Signal Hill	30.0	NR	Abs.	.....	.....	.....	15,000	.....	75,000	.....
Tidewater Oil Co.:											
Ventura field, Ventura County	Ventura	75.0	70.0	Abs.	54,000	13,100	12,300	1,500	.....	62,600	.....
Union Oil Co. of California											
Bell field, Los Angeles County	Santa Fe Spgs.	9.0	6.8	Abs.	.....	.....	.....	.....	35,000	.....	.....
Belgian Anticline field, Kern County	Taft	3.0	1.3	Refr. & Abs.	.....	.....	.....	.....	2,900	.....	.....

Company, Plant, and Location	Nearest Town	M.M.c.f. daily Capacity	M.M.c.f. daily Throughput	Gas Process Method	Production—Gallons Daily Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
CALIFORNIA (Continued)											
Del Valle field, Los Angeles County	Saugus	32.0	18.2	Abs.	22,900	.....	.....	8,500	.....	18,500	.....
Dominguez field, Los Angeles County	Compton	22.0	18.4	Abs.	16,400	.....	.....	.....	.....	46,900	.....
Playa del Rey field, Los Angeles County	Venice	(Permanently abandoned in 1959)									
Santa Maria Valley field, Santa Barbara County	Santa Maria	35.0	27.0	Abs.	20,200	.....	.....	22,000	.....	35,200	.....
Stearns-Brea field, Orange County	Brea	25.0	18.6	Abs.	23,200	.....	.....	.....	.....	42,300	.....
West Coast Refining Co.											
Richfield field, Orange County	Placentia	12.5	4.2	Abs.	.....	.....	.....	.....	.....	26,500	.....
Total‡		1,808.0	1,275.7		759,919	61,437	115,282	217,112	159,470	2,280,444	.....

*Gas injection. †Capacity figures. ‡Normal butane total includes butanes that are not split.

Colorado

California Co.											
Rangely field, Rio Blanco County	Rangely	70.0	70.0	NR	30,000	.....	.....	20,000	.....	40,000	.....
Continental Oil Co.											
Little Beaver field, Washington County	Brush	12.0	6.5	Refr.	24,330	.....	.....	.....	5,430	18,370	.....
El Paso Natural Gas Co.											
Ignacio field, La Plata County	Durango	300.0	144.0	Abs.	29,200	.....	42,000	.....	.....	29,200	.....
Ginther Gasoline Plants, N. C.											
Goodrich field, Morgan County	Fort Morgan	10.0	9.5	Abs.	10,000	.....	10,000	.....	.....	8,000	.....
Lewis Creek field, Logan County	Peetz	5.0	5.0	Abs.	3,000	.....	.....	5,000	.....	.....	.....
Little Hoot field, Logan County	Sterling	5.0	5.0	Abs.	4,000	.....	.....	5,000	.....	.....	.....
Padroni field, Logan County	Sterling	10.0	6.5	Abs.	3,500	.....	3,500	.....	.....	1,100	.....
Vallery field, Morgan County	Fort Morgan	5.0	5.0	Abs.	2,000	.....	4,000	.....	.....	4,000	.....
Yenter field, Logan County	Sterling	20.0	15.5	Abs.	15,000	.....	13,000	.....	.....	7,000	.....
Loffland Co.											
Fort Morgan field, Morgan County	Fort Morgan	8.0	7.0	Refr.	5,000	.....	3,000	.....	.....	4,000	.....
Mountain Fuel Supply Co.											
Hiawatha field	Moffat	15.0	13.0	Refr.	.....	.....	.....	.....	.....	*1,100	.....
Powder Wash field	Moffat	16.0	6.0	Refr.	.....	.....	.....	.....	.....	*1,190	.....
Pure Oil Co.											
Adena field, Morgan County	.....	28.0	20.0	Abs.	43,100	.....	8,000	.....	35,100	.....	.....
Total†		504.0	313.0		169,130	.....	83,500	30,000	40,530	113,960	.....

*Includes heavier ends. †Normal butane total includes butanes that are not split.

Illinois

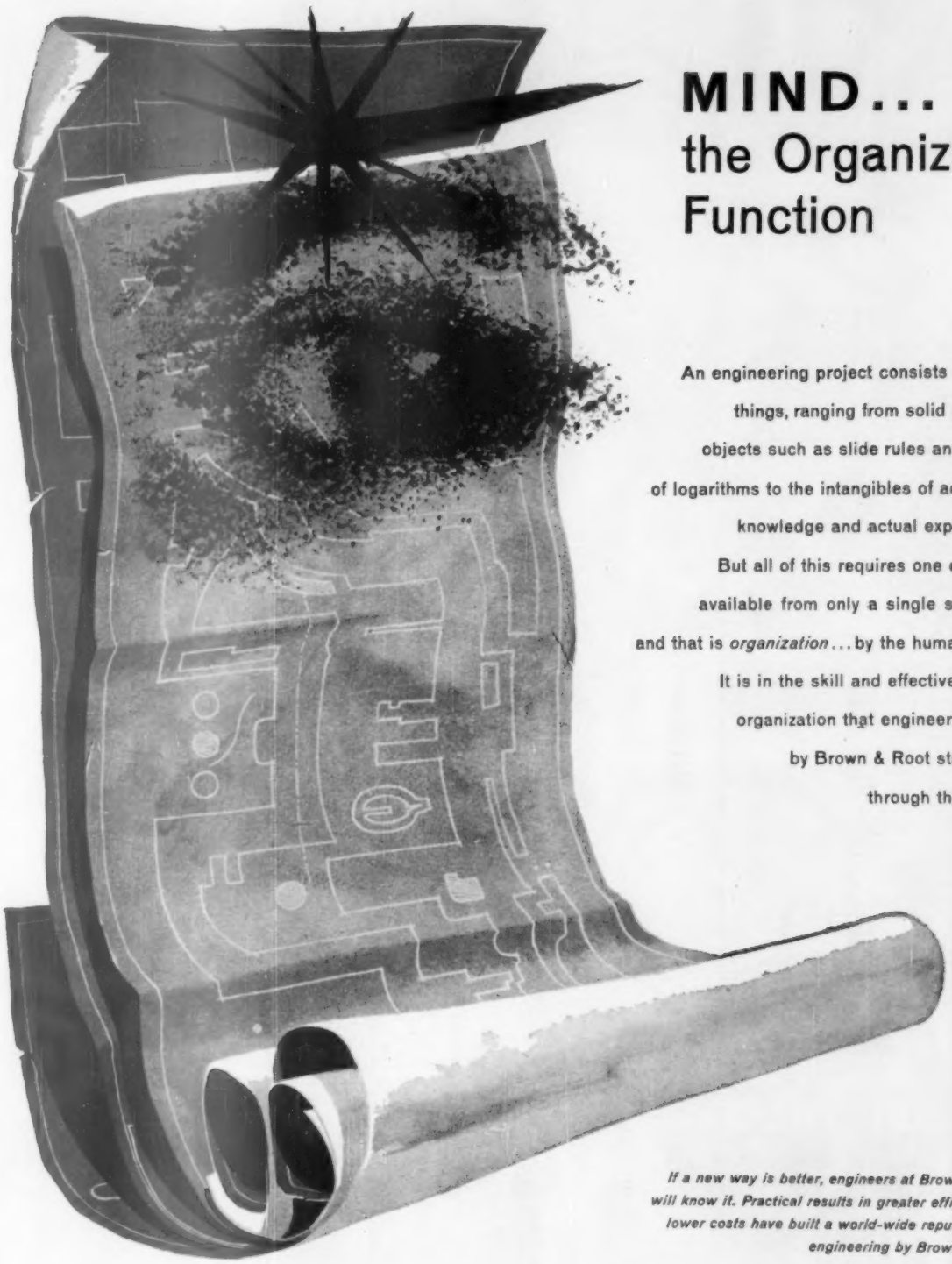
Macdonell Co. of Lima, Inc.											
Sara Dee field, Crawford County	Oblong	0.1	(No salable production in 1959)								
National Petro-Chemicals Corp.											
Tuscola plant, Douglas County	Tuscola	560.0	528.7	NR	548,000	.....	65,000	.....	.....	27,000	.....
Texaco Inc.*											
Hoodville plant, Hamilton County	McLeansboro	7.0	NR	Abs.	.....	.....	.....	59,000	.....	18,000	.....
Salem plant, Marion County	Salem	6.0	NR	Abs.	.....	.....	.....	45,000	.....	22,000	.....
Warren Petroleum Corp.											
Plant No. 23, Crossville field, White County	Crossville	NR	3.0	Abs.	14,242	.....	.....	8,865	.....	8,351	.....
Total		576.1	544.7		562,242	.....	65,000	112,865	.....	75,351	.....

*Capacity.

Company, Plant, and Location	Nearest Town	M.M.c.f. daily Capacity	M.M.c.f. daily Throughput	Gas Process Method	Production—Gallons Daily Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
Kansas											
Cities Service Oil Co. (Del.)											
Burrton-Stone field, Reno County	Burrton	5.0	3.0	Abs.	3,000	.....	4,000	.....	.....	5,000	.....
Wichita plant, various fields, Sedgwick County	Wichita	120.0	113.0	Abs.	35,000	13,000	30,000	.....	.....	47,000	.....
Colorado Interstate Gas Co.											
Hugoton field, Kearney County	Lakin	215.0	76.0	Abs.	.....	.....	.....	.....	.....	8,631	.....
Dunn-Mar Oil & Gas Co.											
Otis field, Rush County	Otis	5.0	NR	NR	.....	.....	.....	1,000	.....	4,000	.....
Hugoton Production Co.											
Hugoton field, Grant County	Ulysses	90.0	76.0	Abs.	20,634	.....	19,930	.....	.....	17,606	.....
Kansas-Nebraska Natural Gas Co., Inc.											
Hugoton field, Kearny County	Deerfield	125.0	100.0	Abs.	2,100	.....	.....	2,000	.....	14,500	.....
Mobil Oil Co.											
Hickock plant, Hugoton field, Stephens County	Ulysses	100.0	83.0	Abs.	11,000	.....	8,000	.....	.....	24,000	.....
Spivey plant, Spivey-Grabs field, Harper County	Attica	35.0	40.0	Abs.	2,500	.....	11,000	.....	.....	21,000	.....
Northern Natural Gas Co.											
Hugoton field, Finney County	Holcomb	185.0	NR	Refr.	.....	.....	.....	.....	.....	9,300	.....
Hugoton field, Seward County	Sublette	325.0	NR	Abs.	.....	.....	.....	.....	.....	19,350	.....
Pan American Petroleum Corp.											
Hugoton field, several counties	Ulysses	325.0	200.0	Abs.	46,536	16,464	44,814	7,686	.....	54,642	.....
Panhandle Eastern Pipe Line Co.											
Hugoton field, Seward County	Liberal	240.0	238.0	NR	14,490	.....	25,562	.....	.....	58,334	.....
Skelly Oil Co.*											
Barber County	.....	60.0	NR	Abs.	.....	.....	.....	.....	†54,000	.....	.....
Total		1,830.0	1,504.0		135,260	29,464	143,306	10,686	54,000	283,363	.....
Kentucky											
Ashland Oil & Refining Co.											
Big Sinking field, Lee County	Fixer	0.7	0.4	NR	.....	.....	.....	.....	1,100	.....	.....
Martha field, Johnson County	Martha	5.5	0.7	NR	.....	.....	.....	.....	170	.....	.....
Kentucky West Virginia Gas Co.											
Dwale plant, Floyd County	.....	40.0	30.0	Abs.	.....	.....	.....	.....	.....	4,000	.....
Tennessee Gas Pipeline Co.											
Gabe plant	.....	925.0	890.0	NR	.....	.....	.....	365,000	.....	60,000	.....
United Fuel Gas Co.											
Leach plant, Boyd County	Catlettsburg	120.0	(Shut down)								
Warfield plant, Martin County	Warfield	40.0	(Shut down)								
Total		1,131.2	921.1		.....	.....	.....	365,000	1,270	64,000	.....
Louisiana											
Amerada Petroleum Corp.											
Lake Chicot field, St. Martin Parish	Baton Rouge	2.5	1.4	Abs.	.....	.....	.....	.....	1,660	.....	.....
Leleux field, Vermilion Parish	Crowley	20.0	9.9	Abs.	.....	.....	.....	.....	14,309	.....	.....
Anchor Gasoline Corp.											
East Krotz Springs plant, Point Coupee Parish	Krotz Springs	25.0	14.8	Abs.	7,100	.....	.....	7,480	.....	3,223	.....
Eola plant, Avoyelles Parish	Eola	15.0	10.6	Abs.	.....	.....	.....	4,940	.....	4,800	.....
North Tepetate plant, Acadia Parish	Eunice	27.0	21.9	Abs	.....	.....	.....	10,300	.....	3,850	.....
Anse La Butte Gasoline Co.											
Anse La Butte field, St. Martin Parish	Lafayette	10.0	6.0	NR	.....	.....	.....	.....	5,500	.....	.....

*Capacity figures. †Combined stream is separated into products at the plant.

Company, Plant, and Location	Nearest Town	M.M.c.f. daily Capacity	M.M.c.f. daily Throughput	Gas Process Method	Production—Gallons Daily Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
LOUISIANA (Continued)											
Arkansas Fuel Oil Corp.											
Langston plant, Homer field, Claiborne Parish	Homer	0.6	0.5	Comp.	.....	.....	.....	.....	.....	4,093	.....
Arkansas Louisiana Chemical Corp.											
Ada Bistineau field, Webster Parish	Heflin	60.0	50.0	Abs.	.....	.....	.....	9,400	.....	*17,700	[11]800
North Ruston field, Lincoln Parish	Ruston	50.0	40.0	Abs.	3,600	.....	.....	18,700	.....	*11,600	[11]24,700
Rodessa field, Caddo Parish	Rodessa	5.0	5.0	Abs.	.....	.....	.....	2,300	.....	5,200	.....
Sligo field, Bossier Parish	Haughton	60.0	50.0	Abs.	.....	.....	.....	11,000	.....	*16,400	[8]400
Atlantic Refining Co.											
Neale field, Beauregard Parish	Merryville	22.0	16.0	Abs.	11,917	.....	7,918	.....	.....	6,246	.....
Bel Oil Corp.											
North Elton field, Allen Parish	Elton	40.0	30.0	Abs.	.....	.....	.....	3,000	.....	12,000	[8]400
California Co.											
Hico-Knowles field, Lincoln Parish	Ruston	75.0	35.0	Abs.	18,000	.....	.....	9,000	.....	.....	[5]30,100 [9]1,200 [11]1,900
Claiborne Gasoline Co.											
Lisbon field, Claiborne Parish	Homer	150.0	70.0	Abs.	4,000	.....	.....	27,000	.....	*40,000	[9]4,000
Continental Oil Co.											
Louisiana Gas System plant, Calcasieu Parish	Lake Charles	100.0	NR	Abs.	39,000	5,500	17,500	.....	.....	31,000	[1]13,000
Ville Platte field, Evangeline Parish	Ville Platte	115.0	37.5	Abs.	28,320	.....	.....	.....	36,950	.....	.....
Humble Oil & Refining Co., Humble Division											
Opelousas field, St. Landry Parish	Opelousas	190.0	183.1	Abs.	41,300	24,700	22,900	.....	.....	44,700	.....
Hunt Oil Co.											
Lisbon plant, Claiborne Parish	Bernice			(Ceased operations)							
Hunt, H. L.											
Clear Creek field, Beauregard Parish	Reeves	10.0	7.0	Abs.	13,300	.....	.....	9,000	.....	5,230	.....
Mississippi River Fuel Corp.											
Perryville field, Morehouse Parish	Monroe	300.0	300.0	Abs.	.....	.....	.....	.....	5,500	.....	.....
Mobil Oil Co.											
Cameron Meadows central separator facilities, several fields, Cameron Parish	Johnsons Bayou	150.0	61.0	Abs.	.....	.....	.....	.....	108,594	.....	.....
Hurricane Creek field, Beauregard Parish	Longville	4.4	4.2	Comp.	.....	.....	.....	4,768	.....	5,941	.....
Mamou field, Evangeline Parish	Mamou	7.0	4.5	Abs.	.....	.....	.....	6,364	.....	7,796	.....
Runnels Gas Products Corp. (subsidiary of Union Texas Natural Gas Corp.)											
Eunice plant, Acadia Parish	Eunice	450.0	450.0	Abs.	114,000	38,000	31,000	.....	.....	74,000	.....
Shell Oil Co.											
Iowa field, Calcasieu Parish	Iowa	70.0	37.0	Abs.	3,000	.....	.....	.....	.....	33,000	.....
Southwest Gas Producing Co., Inc.											
Dubach field, Lincoln Parish	Dubach	190.0	90.0	Abs.	59,000	13,400	29,400	.....	.....	.....	[5]135,000
Sun Oil Co.											
Delhi field, Richland Parish	Delhi	14.4	9.7	Abs.	17,373	4,577	8,132	.....	.....	12,598	[3]3,687
Sunray Mid-Continent Oil Co.											
West Tepetate field, Jefferson Davis Parish	Elton	7.5	7.9	Abs.	2,170	1,153	.....	.....	.....	3,567	†206
Superior Oil Co.											
Lowry field, Cameron Parish	.....	300.0	248.0	Abs.	55,364	28,573	19,013	.....	.....	38,680	[8]5,022
Texaco Inc.‡											
Paradis plant, St. Charles Parish	Paradis	240.0	NR	Abs.	.....	.....	.....	61,000	.....	40,000	.....
Tidewater Oil Co.											
Venice field, Plaquemines Parish	Venice	45.0	42.0	Abs.	15,000	.....	11,000	.....	.....	10,000	.....
Union Texas Natural Gas Corp.											
Rayne pipeline, Acadia Parish	Rayne	NR	700.0	Abs. & Refr.	178,000	47,000	42,000	.....	.....	73,000	.....
Toca pipeline, St. Bernard Parish	St. Bernard	NR	143.0	Abs. & Refr.	35,000	14,000	12,000	.....	.....	19,000	.....



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Company, Plant, and Location	Nearest Town	M.M.c.f. daily Capacity	M.M.c.f. daily Throughput	Gas Process Method	Production—Gallons Daily Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
LOUISIANA (Continued)											
United Gas Pipe Line Co.											
Koran plant, Sligo and Bistineau fields, Bossier and Webster parishes	Haughton	93.5	84.0	Abs.	.....	.....	.....	7,300	.....	18,000	.....
Rodessa field, Caddo Parish	Vivian	16.5	5.9	Abs.	.....	.....	.....	2,400	.....	2,900	.....
Warren Petroleum Corp.											
Plant No. 67, Homer field, Claiborne Parish	.....	NR	1.0	Abs.	.....	.....	.....	.....	.....	5,182	.....
Whitton, E. A.											
Shreveport field, Caddo Parish	Shreveport	2.0	0.8	Abs.	.....	.....	.....	.....	.....	1,800	.....
Total§		3,711.4	3,117.7		645,444	176,903	200,863	193,952	172,513	551,506	220,415
Total§		3,711.4	3,117.7		645,444	176,903	200,863	193,952	172,513	551,506	220,415

*Includes heavier ends. †Type not reported. ‡Capacity figures. §Normal butane total includes butanes that are not split.

Michigan

Dow Chemical Co.											
Beaver Creek field, Crawford County	Grayling	12.0	5.0	Refr.	.....	.....	.....	6,000	.....	.....	.....

Mississippi

California Co.											
Brookhaven field, Lincoln County	Brookhaven	45.0	40.0	Abs.	1,500	.....	.....	5,300	.....	10,200	.....
Shell Oil Co.											
Little Creek field, Pike County	Brookhaven	5.0	4.5	Refr.	3,000	.....	.....	.....	.....	8,000	.....
Total		50.0	44.5		4,500	.....	.....	5,300	.....	18,200	.....

Montana

Union Oil Co. of California											
Cut Bank field, Glacier County	Cut Bank	60.0	22.8	NR	5,800	.....	.....	7,300	.....	6,100	.....
Union Texas Natural Gas Corp.											
Pine Unit, Wibaux County	Glendive	NR	6.0	Abs.	24,600	.....	10,000	.....	.....	7,400	.....
Total		66.0	28.8		30,400	.....	10,000	7,300	.....	13,500	.....

Nebraska

Antelope Gas Products Co.											
Long field, Kimball County	Kimball	8.5	7.8	Abs.	29,200	.....	6,800	.....	.....	19,000	.....
Ginther, Warren & Co.											
Dorman field, Cheyenne County	(Operation of this plant has been discontinued)										
Kansas-Nebraska Natural Gas Co., Inc.											
Big Springs field, Deuel County	Ogallala	35.0	35.0	Abs. & Refr.	12,000	.....	3,500	.....	.....	3,300	.....
Ohio Oil Co.											
Huntsman field, Cheyenne County	Sidney	12.5	10.5	Abs.	11,673	.....	9,332	.....	.....	8,099	.....
West Sidney field, Cheyenne County	Sidney	12.5	8.7	Abs.	12,522	.....	7,275	.....	.....	6,551	.....
Total*		68.5	62.0		65,395	.....	26,907	.....	.....	36,950	.....

*Normal butane total includes butanes that are not split.

EXPERIENCE-

O. L. OLSEN CO. HAS IT!

112 Projects Since 1945

1945

Mid-Co. — Malakoff, Texas

1946

T G T — Jefferson, Texas
Southern Minerals — Agua Dulce, Texas
Hunter & Hunter — Novice, Texas

1947

Warren — Fairbanks, Texas
Pan American — Kountze, Texas
T G T — San Salvador, Texas
Gray Wolfe — Pinehurst, Texas

1948

Warren — Fairbanks, Texas
and Mobile, Alabama
Lion — Shuler, Arkansas
Gulf — Kiefer, Oklahoma
Wehlu — Edmund, Oklahoma
Barnsdall — McFaddin, Texas

1949

Texas Co. — Archer City, Texas
Baldridge & King — San Pablo, Texas
Lion — Shuler, Arkansas
Barnsdall — Placedo, Texas
Barnsdall & Sterling — Bloomington, Texas
Reno — Geraldine, Texas

1950

General Crude — Dayton, Texas
Del Rey — Chesterville, Texas
Mid-Valley — Clarkson, Kentucky
Pecos — Orla, Texas
Humble — South Mayes, Texas

1951

Pan American — Willamar, Texas
General Crude — Dayton, Texas
T G T — East Bernard, Texas
Texas Co. — Snyder, Texas
Del Rey — Chesterville, Texas
Sunray — Placedo, Texas

1952

Mid-Valley — Clarkson, Kentucky
General Crude — Clairemont, Texas
E P N G — Orla, Texas
T G T — East Bernard
and Victoria, Texas
Humble — South Mayes, Texas
Texas Co. — Snyder, Texas
Del Rey — Chesterville, Texas
Shell — Gohlke, Texas

1953

Humble — Trawick, Texas
Texas Co. — Paradis, Louisiana
Socrec — Snyder, Texas
Tennessee Production — Banquete
and Chesterville, Texas
Warren — Fairbanks, Texas
E P N G — Orla, Texas

1954

Sunray — Ingleside, Texas
T G T — Fostoria, Texas
Magnolia — Pegasus, Texas
Texas Gulf Producing — Odessa, Texas
General Crude — Clairemont, Texas
Warren — Conroe, Texas
Sun — Sweetwater, Texas
Texas Co. — Paradis, Louisiana
Tennessee Production — Banquete
and Chesterville, Texas

1955

Murmanill — Fairbanks, Texas
Sharon Ridge Canyon Unit — Snyder, Texas
American Republics — Silsbee, Texas
T G T — Isola, Mississippi
and San Salvador, Texas
Shell — Iowa, Louisiana
O & G P M — Old Ocean, Texas
Humble — Pita, Texas
Kimball Gas Products — Kimball, Nebraska

1956

Stanolind — Anton, Texas
T P P L — La Porte, Texas
Texas Co. — Tampa, Florida
Texas Pet. — Mata, Venezuela
T G T — New Albany
and Isola, Mississippi
Humble — Refugio, Texas

1957

Sohio — Elmore City, Oklahoma
T G T — Cambridge, Ohio
and Lake Providence, Louisiana
Ohio — Orange, Texas
Tidewater — New Hope, Texas
E P N G — Roswell, New Mexico
Wiseco — Bridgeport, Texas
T P P L — La Porte, Texas

1958

Tidewater — New Hope, Texas
Sohio — Elmore City, Oklahoma
E P N G — Roswell, Caprock, Belen,
Laguna, Maljamar, New Mexico
and Crane, Texas
T G T — Levington, New Mexico, Clifton Springs,
New York and Grenada, Mississippi
Pan American — Riverton and Powell, Wyoming
Humble — Flower Bluff, Texas
Texas Co. — Gray, Oklahoma

1959

E P N G — Orla, Texas
Pecos Petroleum Co. — Orla, Texas
Phillips Petroleum Co. — Orla, Texas
Bay Petroleum Co. — La Porte
and Rockport, Texas
T G T — Isola, Mississippi,
Cambridge, Ohio
and Grenada, Mississippi
Tidewater — Houma, Louisiana

1960

Pan American — Riverton, Wyoming and
Artesia, New Mexico
British American — Grady Co., Oklahoma
Texaco, Inc. — Paradis, Louisiana
Antelope Gas Products — Banner Co., Nebraska
Monterey Oil Co. — Fullerton Field, Texas

NATURAL GAS
PROCESSING PLANTS

O. L. OLSEN COMPANY, INC.

ENGINEERS and CONSTRUCTORS

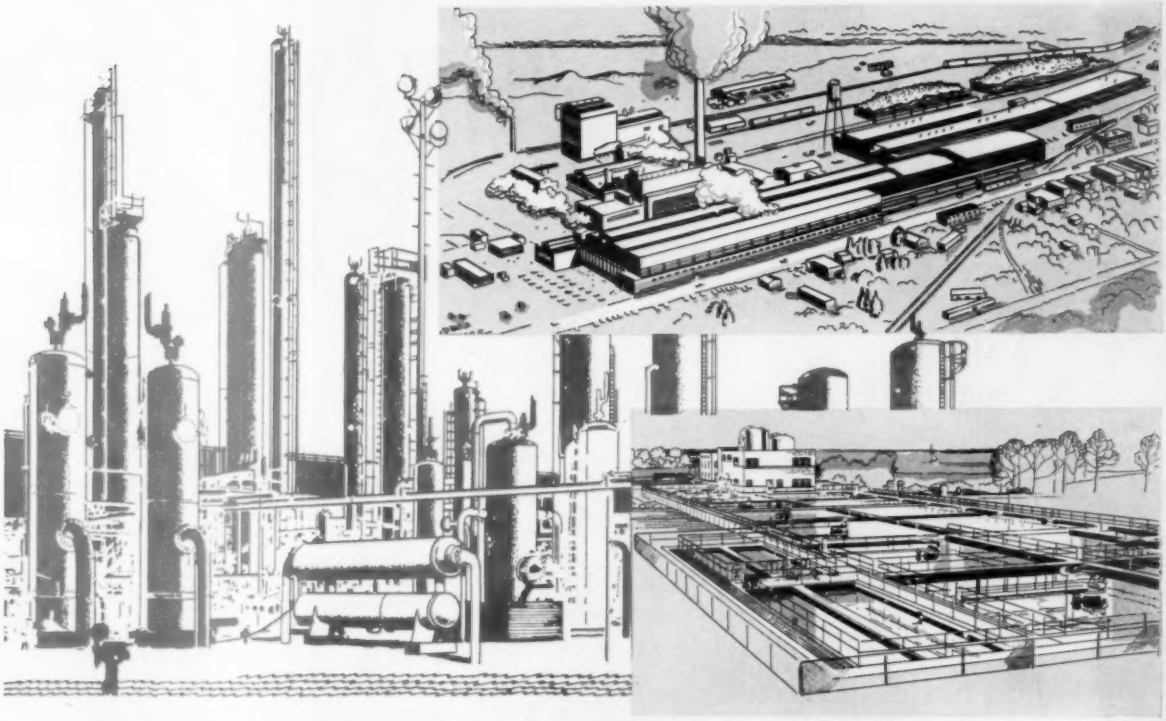
3813 BUFFALO SPEEDWAY
HOUSTON 6, TEXAS

Company, Plant, and Location	Nearest Town	M.M.c.f. daily Capacity	M.M.c.f. daily Throughput	Gas Process Method	Production—Gallons Daily Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
New Mexico											
Atlantic Refining Co.											
Denton field, Lea County	Lovington	29.4	16.5	Abs.	50,197	.....	39,156	.....	.....	27,929	.....
Cabot Carbon Co.											
King field, Lea County	Tatum	6.0	3.0	Refr.	.....	.....	.....	.....	8,459	.....	.....
Continental Oil Co.											
Maljamar plant, Lea County*	Maljamar	15.0	NR	NR	.....	.....	.....	8,492	.....	10,522	‖14,477
El Paso Natural Gas Co.											
Blanco field, San Juan County†	Bloomfield	550.0	364.0	Abs.	.....	.....	.....	.....	(313,400)	.....	.....
Chaco field, San Juan County†	Bloomfield	262.0	223.0	Abs.	.....	.....	.....	.....	(289,300)	.....	.....
Jal No. 1 plant, Lea County‡	Jal	240.0	106.0	Abs.	.....	.....	.....	.....	(29,600)	.....	.....
Jal No. 2 plant, Lea County‡	Jal	130.0	116.0	Abs.	.....	.....	.....	.....	(98,500)	.....	.....
Jal No. 3 plant, Lea County‡	Jal	100.0	90.0	Abs.	.....	.....	.....	.....	(110,500)	.....	.....
Jal No. 4A plant, Lea County‡	Jal	185.0	188.0	Abs.	.....	.....	.....	.....	(117,500)	.....	.....
Jal No. 4B plant, Lea County (fractionation plant for other Jal plants)	Jal	....	....	....	92,400	.....	123,600	.....	.....	136,800	.....
San Juan River field, San Juan County	Farmington	70.0	64.0	Abs.	8,500	.....	13,200	.....	.....	13,500	.....
Wingate fractionation plant (for liquid products from plants at Aneth, Utah, and Blanco and Chaco, N. M.), McKinley County	Gallup	....	....	....	269,900	27,500	28,300 292,200	.....	.....	276,700	.....
Frontier Natural Gasoline Co.											
Grayburg-Jackson field, Eddy County	Loco Hills	7.0	6.5	NR	.....	.....	.....	16,000	16,000	6,000	.....
Permian Basin Pipeline Co.											
Lea County	Hobbs	200.0	160.0	NR	.....	.....	.....	50,400	.....	54,000	.....
Phillips Petroleum Co.											
Eunice field, Lea County	Oil Center	115.0	NR	Abs.	.....	.....	.....	.....	200,000	.....	.....
Hobbs field, Lea County	Hobbs	25.0	NR	Abs.	.....	.....	.....	.....	50,000	.....	.....
Lee field, Lea County	Hobbs	65.0	NR	Abs.	.....	.....	.....	.....	185,000	.....	.....
Sinclair Oil & Gas Co.											
Lea County	Tatum	13.0	13.0	Refr.	12,000	.....	.....	18,000	.....	12,000	.....
Skelly Oil Co.§											
Lea County	.....	142.0	NR	Abs.	.....	.....	.....	.....	¶354,000	.....	.....
Southern Union Gas Co.											
Kutz Canyon field, San Juan County	Bloomfield	35.0	35.0	Abs.	10,000	.....	13,000	.....	.....	10,000	.....
Lybrook field, Rio Arriba County	Lybrook	62.5	45.0	Abs. & Refr.	36,000	.....	27,000	.....	.....	15,000	.....
Valley Gas Corp.											
Anderson Ranch field, Lea County	Lovington	5.0	3.5	Refr.	.....	.....	.....	.....	24,000	.....	.....
Loco Hills field, Eddy County	Artesia	8.0	5.0	Refr.	7,000	.....	3,100	.....	.....	3,900	.....
Warren Petroleum Corp.											
Plant No. 18, Monument field, Lea County	.....	NR	86.0	Abs.	38,254	.....	.....	46,390	.....	46,728	.....
Plant No. 46, Saunders field, Lea County	.....	NR	42.0	Abs.	67,344	.....	.....	39,279	.....	31,519	.....
Plant No. 61, Eunice field, Lea County	.....	NR	54.0	Abs.	53,540	.....	.....	37,696	.....	32,420	.....
Total‖		2,446.9	1,983.5		645,135	27,500	539,556	216,257	837,459	677,018	14,477

*Continental has taken over 100% interest in this plant, formerly operated by the Maljamar Cooperative Repressuring Agreement. Production figures shown are from the Journal's 1959 survey. †Products separated at Wingate, N. M., plant. ‡Products separated at Jal No. 4B plant. §Capacity figures. ¶Combined stream is separated into products at the plant. ‖Normal butane total includes butanes that are not split.

North Dakota											
Signal Oil & Gas Co.											
Plant No. 12, Tioga and Beaver Lodge fields, Williams County	Tioga	65.0	41.0	Abs.	84,000	.....	50,000	....	. .	30,000	.....

A Dependable Source OF INDUSTRIAL CHEMICALS



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(OR 150 Lb. Cylinders)

50% - 73% CAUSTIC SODA

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(Tank-Car OR Tank-Truck Quantities)

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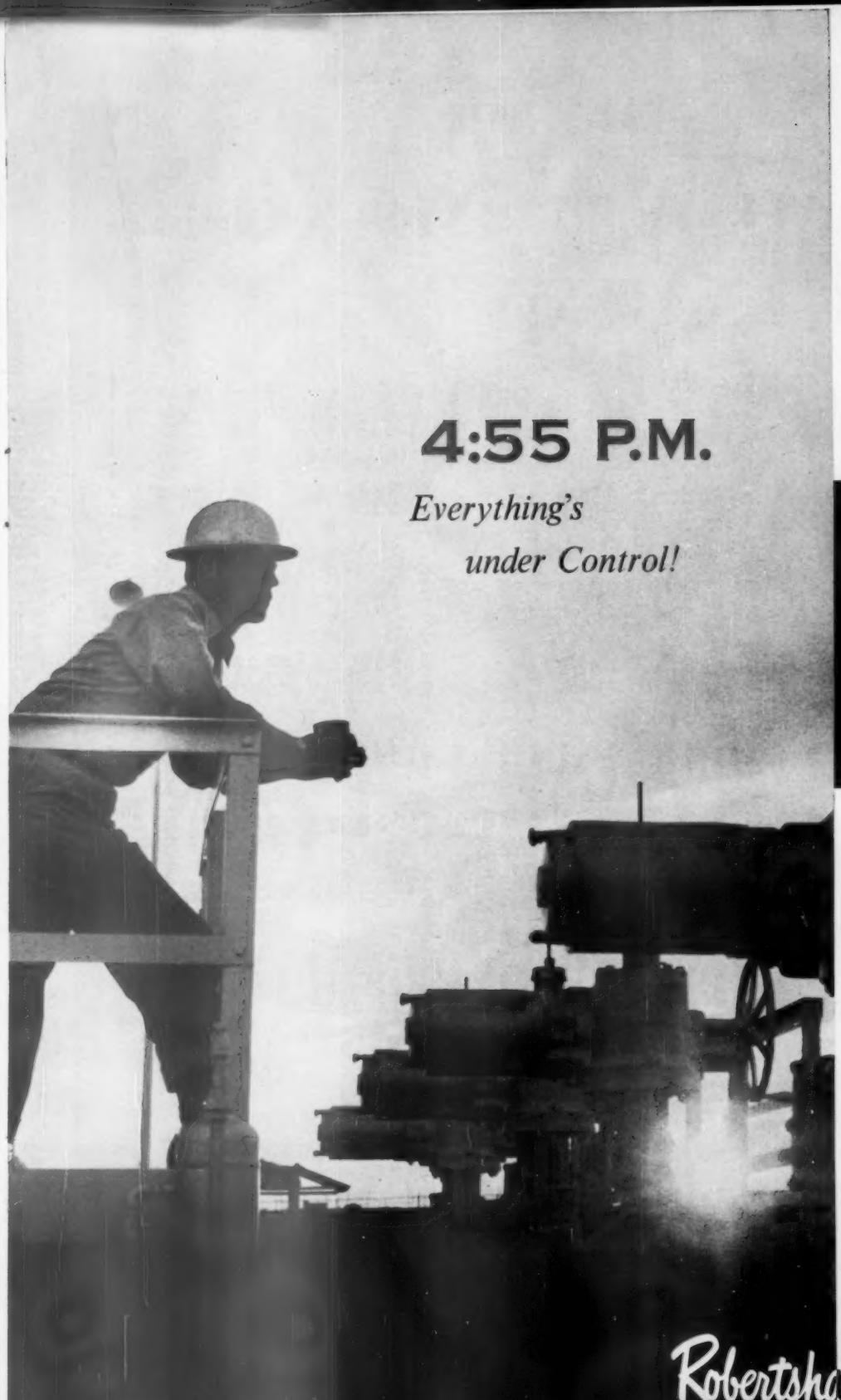
ARKANSAS LOUISIANA CHEMICAL CORPORATION

A SUBSIDIARY OF ARKANSAS LOUISIANA GAS COMPANY

Company, Plant, and Location	Nearest Town	M.M.c.f. daily		Gas	Production—Gallons Daily						
		Capacity	Throughput	Process Method	Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
Oklahoma											
Apache Gasoline Co.											
West Brock field, Carter County	Ardmore	4.0	2.5	Abs.	.....	.....	.....	7,518	.....	4,998	.....
Boswell-Frates Co.*											
Norfolk field, Payne County	Cushing	1.0	NR	NR	.....	.....	.....	.....	1,200	.....	.....
Edna field, Creek County	Bristow	1.5	NR	NR	.....	.....	.....	.....	800	.....	.....
Champlin Oil & Refining Co.											
Witcher field, Oklahoma County	Okla. City	30.0	18.0	Abs.	10,600	.....	4,400	.....	.....	17,892	.....
Cities Service Oil Co. (Del.)											
Ambrose plant, transmission line, Kay County	Blackwell	290.0	245.0	Abs.	82,000	20,000	51,000	.....	.....	61,000	.....
Bodine plant, Oklahoma City field, Oklahoma County	Okla. City	7.0	5.0	Abs.	5,000	.....	5,000	.....	.....	6,000	.....
Guymon plant, Hugoton field, Texas County†	Guymon	...	...	Abs.	.....	.....	.....	.....	.....	8,000	.....
Continental Oil Co.											
Short Junction field, Cleveland County	Okla. City	60.0	38.6	Abs.	21,740	.....	.....	16,270	.....	20,700	.....
Dorchester Corp.											
Panoma plant, Guymon-Hugoton field, Texas County	Hooker	130.0	71.1	Abs.	21,272	7,435	18,870	.....	.....	‡17,170	.....
Eason Oil Co.											
Plant No. 3, Crescent-Lovell field, Logan County	Crescent	13.0	9.4	Abs.	8,469	.....	.....	6,151	.....	9,563	.....
Ells, Harry, Inc.											
Shell Barco plant, Healdton field, Carter County	Healdton	2.6	1.6	Abs.	4,000	.....	.....	.....	10,000	‡6,000	.....
Excelsior Oil Corp. (subsidiary of Kansas-Nebraska Natural Gas Co., Inc.)											
Tyrone plant, Guymon-Hugoton field, Texas County	Tyrone	45.0	47.0	Abs. & Refr.	9,000	.....	11,000	.....	.....	12,000	.....
Frame Natural Gasoline Co.											
Pawnee County	Cleveland	NR	5.0	....	.....	.....	.....	.....	.....	1,300	.....
Gasoline Plant Management Co.											
Lucien Unit plant, Noble County	Lucien	7.0	6.0	Abs.	12,000	.....	6,000	.....	.....	6,000	.....
Grimes, Otha H.											
Pauls Valley field, Garvin County	Pauls Valley	5.0	2.5	Abs.	.....	.....	.....	6,006	.....	3,990	.....
Grimes & Grimes											
Okemah plant, Okfuskee County	Okemah	1.0	0.5	Abs.	.....	.....	.....	.....	.....	1,008	.....
Weleetka plant, Okfuskee County	Weleetka	15.0	14.0	Abs.	.....	.....	.....	2,478	.....	2,520	.....
Grimes Gasoline Co.											
Wetumka plant, Hughes County	Wetumka	15.0	10.0	Abs.	.....	.....	.....	2,016	.....	3,990	.....
Highway Gasoline Co.											
Middle Peck and West Peck fields, Lincoln County	Stroud	5.0	4.0	Abs.	.....	.....	.....	7,980	.....	4,032	.....
Hugoton Plains Gas & Oil Co.											
Tyrone plant, Hugoton field, Texas County	Tyrone	120.0	40.0	Abs.	18,850	3,560	7,750	.....	.....	6,920	.....
Humble Oil & Refining Co., Carter Division											
Fitts field, Pontotoc County	Ada	9.0	3.0	Abs.	9,500	.....	3,200	.....	.....	6,200	.....
Kerr-McGee Oil Industries, Inc.											
Fitts field, Pontotoc County	Ada	NR	2.1	Abs.	1,000	.....	2,800	.....	.....	4,100	.....
Happy Valley field, Lincoln County	Cushing	NR	5.4	Abs.	2,000	.....	3,000	.....	.....	3,800	.....
Laffoon field, Okfuskee County	Paden	NR	6.0	Abs.	7,000	.....	5,000	.....	.....	3,000	.....
Stroud field, Creek County	Stroud	NR	10.0	Abs.	8,500	.....	5,500	.....	.....	9,000	.....
Lone Star Gas Co.											
Katie plant, Garvin County	Elmore City	40.0	29.0	Abs.	.....	.....	.....	.....	34,281	.....	.....
Mobil Oil Co.											
Graham plant, Fox-Graham field, Carter County	Healdton	18.0	15.5	Abs.	.....	.....	.....	.....	.....	35,000	.....
Sholem-Alechem field, Stephens County	Duncan	40.0	22.0	Abs.	32,000	.....	9,500	.....	.....	20,000	.....
Moran Gasoline Corp.											
Kendrick field, Lincoln County	Kendrick	9.0	6.5	Abs.	6,000	.....	.....	3,000	18,000	9,000	.....
Neal Gasoline Co.											
Osage County (Plant has been salvaged)	.....	...	...	....	.....	.....	.....	.....	.....	.....	.....
Oklahoma Gas Hydrocarbon Corp.											
Marlow field, transmission line, Stephens County	Marlow	25.0	18.0	NR	.....	.....	.....	7,000	12,000	6,000	.....
Patton & Swab, Inc.											
Edmond field, Oklahoma County	Edmond	20.0	10.0	NR	.....	.....	.....	.....	10,000	.....	.....



4:55 P.M.

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MALFUNCTION DETECTOR
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In five minutes the only maintenance man at this remote pipeline pumping station will leave for the weekend. Everything's under control. On unattended automatic equipment . . . wherever expensive rotating and reciprocating machinery deserves 'round-the-clock malfunction protection . . . specify Vibraswitch. Electrical and pneumatic signaling models that react instantly to changes in acceleration of machinery vibration . . . shutting down, alarming, activating standbys. When will your expensive machinery next break down? How costly and time-consuming will repairs be? Can you afford to be without low-cost Vibraswitch protection? Over 50 conveniently located sales-service offices. Write for address of the one nearest you.

Robertshaw

MANUFACTURERS OF ROBERTSHAW CAPACITANCE ACTUATED LEVEL MEASUREMENT INSTRUMENTS AND MICROSEN INDUSTRIAL PROCESS CONTROL SYSTEMS

Aeronautical and Instrument Division, Robertshaw-Fulton Controls Company, Santa Ana Freeway at Euclid Avenue, Anaheim, California.

Company, Plant, and Location	Nearest Town	M.M.c.f. daily		Gas	Production—Gallons Daily						
		Capacity	Throughput	Process Method	Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
OKLAHOMA (Continued)											
Phillips Petroleum Co.											
Bradley field, Garvin County	Lindsay	120.0	NR	Abs.	.....	.....	.....	.....	250,000	.....	.....
DeNoye plant, Burbank field, Osage County	Shidler	15.0	NR	Abs.	.....	.....	.....	.....	45,000	.....	.....
Edmond plant, Edmond field, Oklahoma County	Edmond	160.0	NR	Abs.	.....	.....	.....	.....	190,000	.....	.....
Hunton plant, Edmond field, Oklahoma County	Edmond	65.0	NR	Abs.	.....	.....	.....	.....	57,000	.....	.....
Oklahoma City field, Oklahoma County	Okla. City	16.0	NR	Abs.	.....	.....	.....	.....	65,000	.....	.....
Reserve plant, Burbank field, Osage County	Fairfax	8.0	NR	Abs.	.....	.....	.....	.....	35,000	.....	.....
Wewoka field, Seminole County	Wewoka	6.0	NR	Abs.	.....	.....	.....	.....	16,000	.....	.....
Pure Oil Co.											
Sapulpa field, Creek County	.....	4.0	3.5	Abs.	.....	.....	.....	.....	.....	4,500	.....
Redco Corp.											
Grisso plant, Seminole field, Seminole County	.....	20.0	17.5	Abs.	30,000	.....	20,000	.....	.....	30,000	.....
Service Gas Products Co.											
Aylesworth field, Marshall County	Madill	2.8	0.7	Abs.	.....	.....	.....	1,101	.....	1,640	.....
Doyle field, Stephens County	Marlow	22.5	19.8	Abs.	.....	.....	.....	15,072	.....	16,137	.....
West Hoover field, Garvin County	Davis	10.0	9.1	Abs.	.....	.....	.....	6,498	.....	8,058	.....
Shell Oil Co.											
Dillard plant, Hewitt field, Carter County	Wilson	8.0	6.0	Abs.	6,000	.....	8,000	.....	.....	14,000	.....
Signal Oil & Gas Co.											
Plant No. 13, Fox-Milroy field, Carter County (includes Sokla plant)	Healdton	70.0	66.0	Abs.	70,000	13,000	26,000	2,700	.....	50,000	.....
Sinclair Oil & Gas Co.											
Cushing field, Creek County	Drumright	14.0	11.0	Abs.	25,000	.....	2,000	.....	.....	51,000	.....
Garber field, Garfield County	Covington	50.0	21.0	Abs.	22,000	5,000	12,000	.....	.....	23,000	.....
Seminole field, Seminole County	Seminole	15.0	11.0	Abs.	35,000	5,000	10,000	.....	.....	35,000	.....
St. Louis field, Pottawatomie County	St. Louis	14.0	8.0	Abs.	28,000	4,000	9,000	.....	.....	25,000	.....
Skelly Oil Co.§											
Velma field, Stephens County	.....	70.0	NR	Abs.	.....	.....	.....	.....	¶150,000	.....	.....
Sohio Petroleum Co.											
Elmore plant, Eola field, Garvin County	Pauls Valley	35.0	33.0	Abs.	.....	.....	.....	.....	73,000	.....	.....
Trindle plant, West Edmond field, Kingfisher County	Edmond	10.0	6.0	Abs.	.....	.....	.....	3,000	.....	4,000	.....
Sterling Gasoline Plant of Garber, Inc.											
Spring Valley field, Garfield County	Garber	20.0	10.0	NR	.....	.....	.....	7,000	.....	8,000	.....
Sun Oil Co.											
Laverne field, Harper County	.....	100.0	79.0	Abs.	43,806	8,009	18,985	.....	.....	18,956	.....
Sunray Mid-Continent Oil Co.											
Carney plant, Lincoln County	Carney	17.5	12.0	Abs.	8,500	.....	5,000	.....	.....	4,000	.....
Criner plant, McClain County	Purcell	8.0	8.0	Abs.	11,000	.....	8,000	.....	.....	5,000	.....
Moore field, Cleveland County	.....	32.0	30.0	Abs.	20,000	.....	15,000	.....	.....	13,000	.....
Texaco Inc.§											
Camrick plant, Beaver County	Gray	50.0	NR	Abs.	.....	.....	.....	47,500	.....	28,500	.....
Davenport plant, Lincoln County	Davenport	15.0	NR	Abs.	.....	.....	.....	30,000	.....	14,700	.....
Warren Petroleum Corp.											
Plant No. 15, Maud field, Pottawatomie County	.....	NR	3.0	Abs.	2,771	.....	.....	5,463	.....	4,305	.....
Plant No. 22, Madill field, Marshall County	.....	NR	14.0	Abs.	13,439	.....	.....	2,288	.....	18,079	.....
Plant No. 33, Maysville field, Garvin County	.....	NR	407.0	Abs.	364,266	.....	.....	146,946	.....	236,032	.....
Plant No. 40, Ringwood field, Major County	.....	NR	25.0	Abs.	13,920	.....	.....	11,433	.....	13,707	.....
Plant No. 57, Marlow field, Grady County	.....	NR	3.0	Abs.	576	.....	.....	.....	.....	1,655	.....
Plant No. 59, Mocane field, Beaver County	.....	NR	30.0	Abs.	9,400	.....	.....	7,670	.....	8,436	.....
Plant No. 60, Kiefer field, Creek County	.....	NR	13.0	Abs.	.....	.....	.....	1,584	.....	23,425	.....
Wunderlich Development Co.											
Kay County	Newkirk	12.0	7.0	Refr.	12,713	.....	5,448	.....	.....	8,296	.....
Total‖		2,426.4	2,028.8		975,322	66,004	272,453	346,674	967,281	957,609	.....

*Figures from 1959 survey. †Drip control plant. ‡Includes heavier ends. §Capacity figures. ¶Combined stream is separated into products at the plant. ‖Normal butane total includes butanes that are not split.

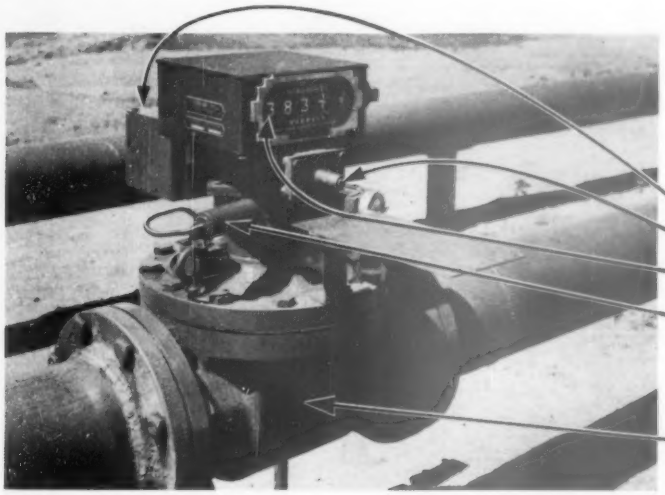
Company, Plant, and Location	Nearest Town	M.M.c.f. daily		Gas	Production—Gallons Daily						
		Capacity	Throughput	Process Method	Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
Pennsylvania											
Mars Co.											
Lamont plant, Elk County	Kane	4.0	3.5	Abs.	.....	.....	.....	.....	.....	600	.....
Pinegrove plant, Venango County	Oil City	3.0	...	Abs.	(Not operating at present)						
Van plant, Venango County	Van	3.0	1.5	Abs.	3,500	.....	2,000	.....	.....	2,000	.....
Pennsylvania Gas Co.											
Roystone station, Warren County	Sheffield	11.0	10.0	Abs.	.....	.....	.....	.....	.....	885	.....
Total		21.0	15.0		3,500	.....	2,000	.....	.....	3,485	.....
Texas											
Amarillo Oil Co.											
Fain plant, West Panhandle field, Potter County	Masterson	100.0	42.0	Abs.	2,760	.....	6,920	.....	.....	7,580	.....
Turkey Creek plant, West Panhandle field, Potter County	Fritch	100.0	24.3	Abs.	3,170	.....	10,400	.....	.....	8,330	.....
Amerada Petroleum Corp.											
Adair field, Terry County	Brownfield	1.5	1.1	Refr.	.....	.....	.....	10,902	.....	3,101	.....
Anchor Gasoline Corp.											
Tabasco plant, Hidalgo County	Mission	32.0	23.5	Abs.	5,560	.....	.....	8,330	.....	5,575	.....
Arkansas Fuel Oil Corp.											
Carthage field, Panola County	Carthage	100.0	65.0	Abs.	20,951	9,029	9,850	.....	.....	.....	[3]2,682 [5]38,967 [11]5,765
East Texas field, Gregg County	Greggton	50.0	22.4	Abs.	32,855	.....	20,061	.....	.....	17,477	.....
May field, Kleberg County	Riviera	50.0	30.4	Abs.	13,092	.....	9,034	.....	.....	7,685	.....
Arkansas Louisiana Chemical Corp.											
Carthage field, Panola County	Carthage	40.0	25.0	Abs.	.....	.....	.....	11,900	.....	*17,200	[11]300
Jefferson field, Marion County	Jefferson	31.0	10.0	Abs.	.....	.....	.....	5,200	.....	*6,900	[11]100
North Lansing field, Harrison County	Hallsville	30.0	30.0	Abs.	.....	.....	.....	.....	6,500	.....	.....
Waskom field, Harrison County	Waskom	205.0	165.0	Abs.	21,600	15,600	26,900	.....	.....	*110,000	[6]200 [5]3,700 [11]7,300
Atlantic Refining Co.											
Block 31, Crane County	Crane	61.0	61.0	Abs.	54,766	.....	33,835	.....	16,880	19,170	.....
Barnhart Hydrocarbon Corp.											
Barnhart field, Reagan County	Big Lake	25.0	15.0	Abs.	20,000	.....	9,000	.....	.....	15,000	.....
Black Hawk Gasoline Corp.											
Alco-Caddo field, Jack County	Graham	4.0	2.5	Abs.	.....	.....	.....	1,000	5,000	4,000	.....
Bowie Gasoline Co.											
Montague, Hundley, Dodson and various other fields, Montague County	Bowie	20.0	5.5	Abs.	16,500	.....	.....	8,000	.....	3,400	.....
Brazos River Gas Co.											
Palo Pinto County	Mineral Wells	26.0	19.5	Abs.	8,800	.....	.....	10,400	.....	6,850	.....
Breckenridge Gasoline Co.											
Eliasville field, Stephens County	Eliasville	10.0	5.0	Abs.	.....	.....	.....	8,000	.....	8,000	.....
Lodi field, Cass County	Bivins	30.0	21.5	Abs.	.....	.....	.....	20,000	.....	20,000	.....
Cabot Carbon Co.											
Estes field, Ward County	.....	25.0	18.8	Abs.	1,743	3,487	7,974	.....	.....	20,750	.....
Walton field, Eastland County	.....	30.0	31.6	Abs.	1,139	4,080	12,517	.....	.....	21,034	.....
Carthage Co.											
Carthage field, Panola County	Carthage	475.0	280.0	Abs.	67,500	.....	100,000	.....	.....	215,000	[10]150,000 [5]8,500
Caska Corp.											
Wood County	.....	20.0 (Capacity when expansion completed spring 1960)									
Champlin Oil & Refining Co.											
Carthage field, Panola County	Carthage	210.0	230.0	Abs. & Refr.	35,240	23,650	34,070	.....	.....	129,280	.....

Granco® SUCCESS STORY

by Harry Kaindl, GRANCO Southwestern Division Manager

Multimillion barrel recording ...with GRANCO DUO ROTORS! "the twin-turbine meters"

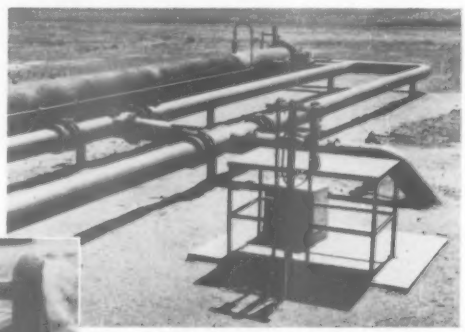
TWO DUO ROTORS meter incoming crude oil production from two streams at a West Texas Pump Station. DUO ROTOR at right, has recorded millions of barrels of crude as of August, 1959. (below) Both DUO ROTORS are fully equipped for accurate, automatic custody transfer recording.



GRANCO Metering Equipment includes:

- **Double take-off drive.**
- **Pulse sender** for remote pipeline control station.
- **Pulse sender connection** for calibration unit.
- **Large numeral counter** reading in barrels and hundredths-barrels.
- **Temperature Compensator** automatically converts expansion or contraction of crude, due to temperature variation, to record at 60° F. volume displacement. Meter and temperature compensator can be **calibrated independently** because of **unique** GRANCO compensator disengagement dial!
- DUO ROTOR METER with opposite-pitch, twin-turbines, geared as a unit to give counters twin drive power for unwavering accuracy for all flow rates, from high to low!

Unique, two-way prover tube, at right, calibrates metering equipment to within .001 (one-thousandth) of-a-barrel accuracy. Below, DUO ROTORS are calibrated weekly on this new, super-modern prover.



Another example of "DUO ROTORS in action"!

Wherever pipeline requirements call for high capacity—high accuracy liquid measurement, investigate GRANCO DUO ROTORS! Sizes — 2½" to 30". Capacities — 300 gpm to 40,000 bph. Equipped with counters, temperature compensators, pre-controls, remote controls, soft-closing balanced valves, accumulators, etc., to fit your operation.

Write today, for reprints of A. J. Granberg's latest article, "Getting top performance from turbine meters"!

GRANBERG CORPORATION

subsidiary of AMERICAN METER COMPANY

1308 SIXTY-SEVENTH STREET • OAKLAND 8, CALIFORNIA

Company, Plant, and Location	Nearest Town	M.M.c.f. daily Capacity	M.M.c.f. daily Throughput	Gas Process Method	Production—Gallons Daily Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
TEXAS (Continued)											
Chillgas Corp.											
Wellman field, Terry County	Wellman	1.5	1.0	Refr.	.....	.....	.....	.....	8,000	.....	.....
Cities Service Oil Co. (Del.)											
Chico-East Chico field, Wise County	Chico	50.0	44.0	Abs.	45,000	.....	34,000	.....	.....	26,000	.....
Lehman plant, West Levelland and Buckshot fields, Cochran County	Lehman	25.0	17.0	Abs.	14,000	.....	10,000	.....	.....	13,000	.....
Pampa field, Gray County	Pampa	50.0	46.0	Abs.	39,000	.....	43,000	.....	.....	47,000	.....
Stonewall plant, various fields, Stonewall County†	Knox City	18.0	17.0	Abs.	23,000	.....	36,000	.....	.....	23,000	.....
West Seminole field, Gaines County	Seminole	15.0	11.0	Abs.	10,000	.....	18,000	.....	.....	12,000	.....
Cities Service Production Co.											
Roberts Ranch field, Midland County	Odessa	35.0	18.0	Abs.	.....	.....	.....	.....	69,000	.....	.....
Coates, George H.											
Rico field, Hidalgo County	Puerto Rico	6.0	3.0	Refr.	.....	.....	.....	.....	.....	2,500	.....
Villarrea plant, Jay Simmons field, Starr County	La Reforma	1.5	1.0	Refr.	.....	.....	.....	.....	.....	2,500	.....
Colorado Interstate Gas Co.											
Bivins plant, Panhandle field, Moore County	Dumas	165.0	85.0	Abs.	.....	.....	.....	.....	27,114	.....	.....
Fourway plant, Panhandle field, Moore County	Dumas	150.0	122.0	Abs.	.....	.....	.....	.....	86,153	.....	.....
Coltexo Corp.											
Lefors No. 78-1 plant, Panhandle field, Gray County	Lefors	50.0	34.5	Abs.	.....	.....	.....	.....	89,188	.....	.....
Columbian Carbon Co.											
Seminole field, Gaines County	Seminole	30.0	(Desulfurization)								
Continental Oil Co.											
KMA field, Wichita County	Electra	11.2	6.5	Abs.	.....	.....	.....	.....	56,390	.....	.....
Ramsey plant, Geraldine field, Reeves County	Pecos	5.0	2.4	Refr.	.....	.....	.....	.....	.....	3,590	.....
Rincon field, Starr County	Rio Grande City	21.5	18.4	Abs.	650	.....	.....	8,560	.....	19,900	.....
Todd Ranch field, Crockett County	Big Lake	9.3	2.1	Abs.	.....	.....	.....	1,020	.....	1,840	.....
Delhi-Taylor Oil Corp.											
McAllen field, Hidalgo County	McAllen	165.0	93.5	Abs.	5,630	10,460	360	15,920	.....	*61,070	.....
Dorchester Corp.											
Cargray plant, Panhandle field, Carson County	White Deer	110.0	61.0	Abs.	28,293	9,084	23,820	.....	.....	*7,180	[3]5,430 [4]5,850 [5]27,320
Texon plant, Big Lake field, Reagan County	Texon	5.5	4.5	Refr.	.....	.....	.....	.....	12,016	.....	.....
El Paso Natural Gas Co.											
Midkiff field, Reagan County	Midland	166.0	157.0	Abs.	211,300	.....	122,300	.....	.....	98,700	.....
Sealy-Smith field, Ward County	Monahans	16.5	15.9	Abs.	5,800	.....	4,000	.....	.....	13,700	.....
Westlake field, Nolan County	Sweetwater	25.0	22.2	Abs.	.....	.....	.....	.....	85,400	.....	.....
Etexas Producers Gas Co.											
Chapel Hill field, Smith County	Tyler	15.0	8.4	Abs.	.....	.....	.....	4,100	.....	9,300	.....
Gillring Oil Co.											
Agua Dulce field, Nueces County	Banquette	50.0	26.0	NR	.....	.....	.....	9,000	.....	7,000	.....
Goliad Corp.											
Clayton plant, Live Oak County	George West	55.0	40.0	Abs.	.....	.....	.....	.....	.....	.....	.....
Hagist plant, Duval County‡	Freer	70.0	35.0	Abs.	60,000	22,000	28,000	.....	.....	52,000	[1]47,000
Kittie plant, Live Oak County	Three Rivers	80.0	68.0	Abs.	.....	.....	.....	.....	.....	.....	.....
Wilcox plant, Lavaca County	Halletsville	250.0	225.0	Abs. & Refr.	6,100	.....	56,000	.....	.....	55,000	.....
Graridge Corp.											
Plant No. 1, Ibex field, Shackelford County	Albany	10.0	5.0	Abs.	.....	.....	.....	3,000	.....	3,000	.....
Plant No. 2, Eastland field, Eastland County	Eastland	10.0	4.0	Abs.	.....	.....	.....	5,000	.....	3,000	.....
Plant No. 3, South Bend field, Young County	South Bend	8.0	8.0	Abs.	7,000	.....	7,000	.....	.....	6,000	.....
Grimes, Otha H.											
North Dora field, Nolan County	Sweetwater	4.5	3.0	Abs.	.....	.....	.....	17,010	.....	7,980	.....
Ringgold field, Clay County	Ringgold	3.0	3.0	Abs.	.....	.....	.....	7,014	.....	2,982	.....
Henderson, Frank C., Trust											
Plant No. 2, West Panhandle field, Hutchinson County	Sanford	60.0	35.0	Abs.	.....	.....	.....	.....	.....	28,500	.....

Company, Plant, and Location	Nearest Town	M.M.c.f. daily		Gas	Production—Gallons Daily						
		Capacity	Throughput	Process Method	Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
TEXAS (Continued)											
Honolulu Oil Corp.											
Prentice field, Yoakum County	Tokio	34.0	11.0	Abs.	.....	.....	.....	.....	451,874	.....	.....
Ropes field, Hockley County	Ropesville	2.0	1.0	Refr. & Comp.	25,574	.....	.....	36,690	.....	23,240	.....
White Flat field, Nolan County	Trent	6.5	4.0	Refr. & Comp.	55,748	.....	.....	176,550	.....	88,790	.....
Houston Hydrocarbon Corp.											
Cardona Lake field, Crane County	Crane	5.0	2.0	NR	.....	.....	.....	.....	7,500	.....	.....
Howsley, A. M.											
Sappington plant, Glen Cove (Jennings) field, Coleman County	Glen Cove	1.8	1.5	NR	.....	.....	.....	1,353	.....	1,654	.....
Huber Corp., J. M.											
Borger plant, Panhandle field, Hutchinson County	Borger	80.0	68.5	Abs.	.....	.....	.....	.....	.....	38,458	.....
Humble Oil & Refining Co.											
Anahuac field, Chambers County	Monroe City	100.0	95.8	Abs.	.....	.....	.....	.....	37,700	.....	.....
Clear Lake field, Harris County	Genoa	200.0	166.9	Abs.	15,000	.....	.....	.....	59,800	.....	.....
Conroe field, Montgomery County	Conroe	29.0	26.9	Abs.	12,900	.....	.....	.....	27,200	.....	.....
East Texas field, Rusk County	Overton	85.0	53.9	Abs.	51,300	10,500	25,100	.....	.....	33,200	.....
Flour Bluff field, Nueces County	Corpus Christi	35.0	27.8	Abs.	.....	.....	.....	12,000	.....	9,300	.....
Heyser field, Calhoun County	Bloomington	18.0	11.1	Abs.	.....	.....	.....	.....	.....	3,700	.....
Jourdanton field, Atascosa County	Jourdanton	26.0	15.7	Abs.	5,200	.....	.....	7,700	.....	10,100	.....
Neches field, Cherokee County	Jacksonville	9.5	5.5	Abs.	.....	.....	.....	.....	29,400	.....	.....
Pickton field, Hopkins County	Pickton	54.0	51.3	Abs.	16,300	.....	17,600	5,500	.....	26,400	.....
Pledger field, Brazoria County	Danciger	190.0	172.1	Abs.	.....	12,900	.....	§76,000	.....	*96,100	.....
Tomball field, Harris County	Tomball	54.0	50.6	Abs.	.....	.....	.....	.....	36,800	.....	.....
Tom O'Connor field, Refugio County	Refugio	160.0	144.2	Abs.	9,000	.....	.....	4,800	.....	32,300	.....
Kerr-McGee Oil Industries, Inc.											
Cactus field, Moore County	Etter	NR	54.0	Abs.	.....	.....	.....	.....	60,000	.....	.....
Pampa field, Carson County	Pampa	NR	35.0	Abs.	18,500	.....	14,500	.....	.....	27,000	.....
Lion Oil Co.											
Diamond "M"-Sharon Ridge plant, Scurry County	Snyder	55.0	25.6	Abs.	123,727	61,164	.....	.....	.....	43,685	.....
Lone Star Gas Co.											
Gordon plant, Palo Pinto County	Gordon	75.0	36.0	Abs.	.....	.....	.....	.....	¶(19,802)	.....	.....
Pueblo plant, Eastland County	Cisco	40.0	13.0	Abs.	.....	.....	.....	.....	¶(9,926)	.....	.....
Springtown plant, Parker County	Springtown	250.0	103.0	Abs.	18,156	2,738	20,372	.....	.....	29,083	[3]3,020
Trinidad plant, Henderson County	Trinidad	240.0	94.0	Abs.	5,207	1,722	9,700	.....	.....	12,331	[3]2,825
Lone Star Producing Co.											
Brooks plant, Stephens County	Breckenridge	110.0	5.0	Abs.	.....	.....	.....	.....	¶(18,479)	.....	.....
Fashing acid gas removal plant, Atascosa County	Karnes City	110.0	46.0	Abs.	.....	.....	.....	.....	.....	*38,725	.....
Plant No. 108, Eastland County	Ranger	12.0	8.0	Abs.	.....	.....	.....	.....	¶(30,465)	.....	.....
RCF plant, Eastland County‖	Ranger	...	...	Abs.	12,681	5,690	23,753	.....	23,676	.....	[3]5,130
Mertzon Corp.											
Mertzon field, Irion County	Mertzon	4.0	2.0	Ads.	.....	.....	.....	7,000	.....	2,500	.....
Midland Gasoline Corp. (agent for Warren Petroleum Corp. and Champlin Oil & Refining Co.)											
Conroe field, Montgomery County	Conroe	42.0	37.0	Ads.	21,000	.....	.....	.....	.....	36,000	.....
Mobil Oil Co.											
Burkburnett field, Wichita County	Burkburnett	1.4	0.7	Refr.	2,610	.....	.....	.....	.....	7,930	.....
Desdemona field, Eastland County	Desdemona	1.3	1.1	Refr.	.....	.....	.....	3,272	.....	5,321	.....
Electra field, Wichita County	Electra	1.2	1.0	Refr.	.....	.....	.....	4,418	.....	5,302	.....
Kermit field, Winkler County	Kermit	10.0	7.2	Abs.	.....	.....	.....	5,264	.....	5,146	.....
Parks Ranch field, Midland County	Midland	20.0	7.0	Comp.	.....	.....	.....	.....	7,425	.....	.....
Pegasus field, Upton County	Midland	60.0	39.9	Abs.	97,880	.....	59,383	.....	.....	51,700	.....
Sabine plant, East Texas field, Gregg County	Kilgore	8.0	3.3	Refr.	18,000	.....	.....	12,000	.....	10,000	.....
Vanderbilt plant, West Ranch field, Jackson County	Vanderbilt	79.0	57.7	Abs.	10,016	.....	.....	.....	34,409	.....	[10]359
Natural Gas Pipeline Co. of America											
Plant No. 151, Panhandle field, Hutchinson County	Fritch	225.0	147.2	Abs.	.....	.....	.....	.....	.....	81,764	.....
Plant No. 152, Panhandle field, Moore County	Stinnett	195.0	119.5	Abs.	.....	.....	.....	.....	.....	54,341	.....

Company, Plant, and Location	Nearest Town	M.M.c.f. daily		Gas	Production—Gallons Daily						
		Capacity	Throughput	Process Method	Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
TEXAS (Continued)											
Natural Gasoline Corp.											
Plant No. 25, Wood County		NR	13.0	Abs.	15,261			37,081		24,089	
Northern Natural Gas Co.											
Spearman field, Ochiltree County	Spearman	100.0	NR	Refr.						12,000	
Odessa Natural Gasoline Co.											
Foster field, Ector County	Odessa	42.0	32.0	NR				65,000		35,000	
Ohio Oil Co.											
North Markham and North Bay City fields, Matagorda County	Bay City	110.0	108.5	Abs.			18,113	68,908			
Phoenix Lake field, Orange County	Orange	12.0	11.1	Abs.	7,989		6,867			4,528	
Pan American Petroleum Corp.											
Hastings field, Brazoria and Galveston counties	Alvin	53.0	51.0	Abs.	9,030	5,334	1,638	4,032		28,476	
Levelland field, Cochran and Hockley counties	Levelland	36.0	18.0	Abs.	20,580		7,728	17,682		22,428	
Luby and Petronilla fields, Nueces County	Bishop	37.0	28.0	Abs.				6,972		20,874	
Midland Farms field, Andrews County	Andrews	15.0	9.0	Refr.					66,360		
Monahans North field, Winkler County	Monahans	12.0	4.0	Refr.					14,364		
North Cowden field, Andrews and Ector counties	Odessa	60.0	70.0	Abs.	68,838		52,962			65,898	
Old Ocean field, Brazoria County	Sweeny	350.0	339.0	Abs.		34,188	36,330			110,712	[2]86,352 [3]19,278
Slaughter field, Cochran and Terry counties	Sundown	110.0	84.0	Abs.	72,744		32,886	43,386		79,842	
South Fullerton field, Andrews County	Andrews	58.0	54.0	Abs.	52,374		31,920	16,632		33,096	
Three Bar field, Andrews County	Kermit	18.0	20.0	Abs.	22,764		9,240	18,606		14,574	
Parade Co.											
No. 1 Giles plant, East Texas field, Rusk County	Overton	12.0	5.0	Abs.	27,170				41,657		
Pecos Co.											
Santa Rosa field, Pecos County	Grand Falls	45.0	30.0	Abs.	15,000		13,500			9,500	
Phillips Petroleum Co.											
Andrews plant, various pools, Andrews County	Andrews	115.0	NR	Abs.					325,000		
Bayou plant, Chocolate Bayou field, Brazoria County	Alvin	360.0	NR	Abs.					410,000		
Benedum plant, Benedum field, Upton County	Midkiff	85.0	NR	Abs.					270,000		
Canadian plant, West Panhandle field, Hutchinson County	Phillips	25.0	NR	Abs.					100,000		
Crane plant, McElroy field, Crane County	Crane	63.0	NR	Abs.					210,000		
Dumas plant, West Panhandle field, Moore County	Phillips	240.0	NR	Abs.					290,000		
Fullerton plant, Fullerton field, Andrews County‡‡	Frankel City	80.0	NR	Abs.					200,000		
Goldsmith field, Ector County‡‡	Goldsmith	440.0	NR	Abs.					800,000		
Hansford plant, West Panhandle field, Hansford County	Guymon	140.0	NR	Abs.					110,000		
Judkins-Harper-South Cowden plant, Harper-Penwell-Jordan field, Ector County	Penwell	42.0	NR	Abs.					145,000		
Lefors plant, East Panhandle field, Gray County	Pampa	54.0	NR	Abs.					70,000		
North plant, East Panhandle field, Gray County	Pampa	5.5	NR	Abs.					40,000		
Pampa plant, East Panhandle field, Gray County	Pampa	25.0	NR	Abs.					100,000		
Pantex plant, West Panhandle field, Hutchinson County	Phillips	56.0	NR	Abs.					110,000		
Pembrook plant, Pembrook field, Upton County	Midkiff	60.0	NR	Abs.					150,000		
Puckett field, Pecos County	Crane	200.0	NR	Abs.					20,000		
Rock Creek plant, West Panhandle field, Hutchinson County	Phillips	240.0	NR	Abs.					220,000		
Sanford plant, West Panhandle field, Hutchinson County	Phillips	126.0	NR	Abs.					150,000		
Seminole field, Gaines County	Seminole	35.0	NR	Abs.					80,000		
Sherman plant, West Panhandle field, Hansford County	Guymon	380.0	NR	Abs.					240,000		
Sneed plant, West Panhandle field, Moore County	Phillips	260.0	NR	Abs.					195,000		
Spraberry plant, Tex-Harvey field, Midland County	Midland	28.0	NR	Abs.					115,000		
Tunstill field, Reeves County	Orla	15.0	NR	Abs.					50,000		
Winkler plant, Emperor field, Winkler County	Wink	26.0	NR	Abs.					45,000		
Pure Oil Co.											
Dollarhide field, Andrews County		65.0	65.0	Abs.	93,000		30,000			60,200	
Van field, Van Zandt County		15.0	6.0	Abs.	11,300				27,400		
Reef Corp.											
East Vealmoor field, Howard and Borden counties	Big Spring	70.0	40.0	Abs. & Refr.	152,000	18,000	64,000			66,000	

Progress in the "petro-chemical future" depends on the Engineering Specialist

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Company, Plant, and Location	Nearest Town	M.M.c.f. daily Capacity	M.M.c.f. daily Throughput	Gas Process Method	Production—Gallons Daily Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
TEXAS (Continued)											
Renwar Oil Corp.											
Mustang Island field, Nueces County	Corpus Christi	50.0	35.0	Refr.	.....	.....	.....	.....	.....	25,200	.....
West Rockport, Aransas County	Rockport	14.0	7.0	Refr.	.....	.....	.....	.....	.....	10,000	.....
Richardson Gasoline Co., Sid Div. of Sid Richardson Carbon Co.											
Keystone field, Winkler County	Kermit	129.0	100.0	Abs.	55,000	.....	35,000	.....	.....	40,000	.....
Shamrock Oil & Gas Corp.											
Moore County	Sunray	400.0	320.0	Abs.	135,000	43,500	134,000	.....	.....	76,500	[3]30,000
Shell Oil Co.											
Bryan No. 17 plant, Panhandle field, Carson County	Skellytown	15.0	11.0	Abs.	.....	.....	.....	.....	.....	34,000	.....
Crossett field, Upton County	McCamey	3.0	3.0	Refr.	2,800	.....	.....	.....	.....	4,000	.....
Provident City field, Lavaca County	Sheridan	80.0	76.0	Abs.	19,000	.....	.....	.....	.....	60,000	.....
TXL field, Ector County	Notrees	112.0	96.0	Abs.	97,000	.....	64,000	.....	.....	57,000	.....
Wasson field, Yoakum County	Denver City	150.0	105.0	Abs.	122,000	.....	.....	.....	.....	151,000	.....
Sinclair Oil & Gas Co.											
Bender field, Montgomery County	Spring	6.0	5.0	Abs.	.....	.....	.....	3,000	.....	3,000	.....
East Texas field, Gregg County	Longview	17.0	7.0	Abs.	40,000	.....	30,000	.....	.....	20,000	.....
East Texas field, Rusk County	Price	17.0	5.0	Abs.	18,000	4,000	10,000	.....	.....	15,000	.....
East Texas field, Rusk and Smith counties	Troup	20.0	14.0	Abs.	8,000	4,000	2,000	.....	.....	20,000	.....
East White Point field, San Patricio County	Taft	21.0	15.0	Abs.	.....	.....	.....	4,000	.....	12,000	.....
Hulldale field, Schleicher County	Eldorado	35.0	35.0	Abs.	22,000	.....	30,000	.....	.....	20,000	.....
Silsbee field, Hardin County	Silsbee	58.0	39.0	Abs.	23,000	12,000	12,000	.....	.....	36,000	.....
Sweetwater Canyon field, Nolan County	Sweetwater	7.0	7.0	Refr.	6,000	.....	.....	13,000	.....	6,000	.....
Skelly Oil Co.**											
Hutchinson, Carson, and Gray counties	.....	220.0	NR	Abs.	.....	.....	.....	.....	600,000	.....	.....
Ochiltree County	.....	52	NR	Abs.	.....	.....	.....	.....	70,000	.....	.....
Southern Minerals Corp.											
Saxet field, Nueces County	Clarkwood	60.0	30.0	Abs.	.....	.....	.....	6,000	16,000	10,000	.....
Stratton field, Nueces County	Bishop	65.0	35.0	Abs.	10,000	.....	.....	1,800	24,000	12,000	.....
Standard Oil Co. of Texas											
Chevron field, Kleberg County	Corpus Christi	67.5	31.5	Ads.	.....	.....	.....	.....	.....	*15,120	.....
North Snyder plant, Kelly-Snyder field, Scurry County	Snyder	30.0	12.5	Refr.	.....	.....	.....	.....	115,920	.....	.....
Sherman plant, Grayson County	Sherman	20.0	11.5	Abs.	.....	.....	.....	.....	24,780	.....	.....
Sivells Bend field, Grayson County	Gainesville	5.0	3.0	Abs.	.....	.....	.....	.....	13,020	.....	.....
Sun Oil Co.											
Jameson field, Coke County	Colorado City	55.0	41.8	Refr.	43,269	.....	30,765	.....	.....	29,907	.....
Sun field, Starr County	Delmita	80.0	65.5	Abs.	26,684	.....	22,325	.....	.....	58,085	.....
Sunray Mid-Continent Oil Co.											
Carancahua Bay plant, Jackson County	Laward	30.0	30.9	Abs.	9,247	5,657	3,919	.....	.....	6,769	.....
Redfish Bay and Mustang Island fields, San Patricio County	Ingleside	NR	158.4	NR	48,295	31,643	20,489	.....	.....	42,610	.....
Snyder plant, Kelly-Snyder field, Scurry County	Snyder	75.0	37.0	Abs.	184,968	25,200	79,800	.....	.....	90,300	.....
Superior Oil Co.											
Ramsey field, Colorado County	.....	55.0	21.0	(Ramsey and Lake Creek cycling plant operate as one unit with separate gas outlets)							
Tennessee Oil Refining Co. (formerly Bay Petroleum Co.)											
Chesterville plant (transmission line), Colorado County	Eagle Lake	100.0	81.0	Abs.	19,371	12,102	.....	27,611	.....	20,864	.....
K. G. Pearce plant (transmission line), Aransas County	Fulton	50.0	44.0	Abs.	17,272	8,241	6,510	.....	.....	11,921	.....
R. R. Dean plant (transmission line), Nueces County	Agua Dulce	100.0	134.0	Abs.	20,086	14,257	18,980	.....	.....	24,789	[2]28,634
Texaco Inc.**											
Electra plant, Wichita County	Electra	2.2	NR	Abs.	.....	.....	.....	19,000	.....	10,000	.....
Fuller plant, Scurry County	Snyder	28.0	NR	Abs.	.....	.....	.....	89,000	.....	50,000	.....
Texas Gas Corp.											
Jefferson County	Winnie	240.0	190.0	All.	39,060	22,890	28,266	.....	.....	*176,400	[1]22,260
											[3]12,600
											[5]105,000
											[6]23,100

Company, Plant, and Location	Nearest Town	M.M.c.f. daily Capacity	M.M.c.f. daily Throughput	Gas Process Method	Production—Gallons Daily Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
TEXAS (Continued)											
Texas Gulf Producing Co.											
Headlee field, Ector County	Odessa	34.0	24.0	Abs.	.....	.....	.....	.....	84,000	.....	.....
Texas Pacific Coal & Oil Co.											
Veale plant, Caddo field, Stephens County	Caddo	6.0	1.6	Comp.	.....	.....	5,424	.....	.....	6,156	.....
Velta plant, Pardue-Toler field, Fisher County	Hamlin	5.0	2.8	Comp.	3,959	.....	6,158	.....	.....	4,433	.....
Tidewater Oil Co.											
Cayuga field, Anderson County	Cayuga	25.0	13.0	Abs.	.....	.....	.....	.....	13,500	.....	.....
West Bernard field, Wharton County	East Bernard	32.0	21.0	Abs.	.....	.....	.....	5,100	.....	13,860	.....
Turner & West Gasoline Plant											
Loving plant, Young County	Loving	1.5	1.0	Abs.	.....	.....	.....	3,685	.....	2,322	.....
Peter's plant, James pool, Young County	Graham	3.0	2.9	Abs.	.....	.....	.....	5,280	.....	2,737	.....
Union Texas Natural Gasoline Corp.											
Benedum field, Upton County	Rankin	NR	56.0	Abs.	103,000	11,000	43,000	.....	.....	43,000	.....
Perkins field, Coke County	Silver	NR	65.0	Abs.	126,000	.....	69,000	.....	.....	65,000	.....
Walnut Bend field, Cooke County	Gainesville	NR	16.0	Abs.	42,000	6,000	14,000	.....	.....	18,000	.....
Wimberly field, Jones County	Abilene	NR	10.0	Abs.	30,000	.....	17,000	.....	.....	13,000	.....
United Gas Pipe Line Co.											
Agua Dulce field, Nueces County	Banquette	30.0	21.5	Abs.	.....	.....	.....	750	.....	7,800	.....
Cabeza Creek field, Karnes County	Runge	100.0	84.2	Abs.	5,772	.....	.....	36,900	.....	30,750	.....
Carthage field, Panola County	Carthage	220.0	170.0	Abs.	32,700	15,450	25,200	3,800	.....	50,600	.....
Coy City field, Karnes County	Karnes City	40.0	38.5	Abs.	2,550	.....	.....	5,900	.....	9,600	.....
Warren Petroleum Corp.											
Plant No. 28, McLean field, Wheeler County	.....	NR	26.0	Abs.	7,006	.....	.....	19,957	.....	47,121	.....
Plant No. 30, Breckenridge field, Stephens County	.....	NR	8.0	Abs.	12,219	.....	.....	21,684	.....	16,495	.....
Plant No. 31, Gladewater field, Gregg County	.....	NR	8.0	Abs.	38,810	.....	.....	16,964	.....	29,574	.....
Plant No. 62, Monahans field, Ward County	.....	NR	21.0	Abs.	.....	.....	.....	.....	.....	18,373	.....
Plant No. 63, Runnels field, Runnels County	.....	NR	4.0	Abs.	.....	.....	.....	7,327	.....	3,423	.....
Plant No. 64, Waddell field, Crane County	.....	NR	81.0	Abs.	78,339	.....	.....	66,413	.....	52,798	.....
Plant No. 66, Spear field, Gregg County	.....	NR	7.0	Abs.	29,240	.....	.....	16,570	.....	28,327	.....
Plant No. 20, Fairbanks field, Harris County	.....	NR	30.0	Abs.	398	.....	.....	6,393	.....	10,339	.....
Plant No. 27, Holliday field, Archer County	.....	NR	13.0	Abs.	20,334	.....	.....	34,800	.....	21,181	.....
Plant No. 47, Gregg-Tex field, Gregg County	.....	NR	6.0	Abs.	30,673	.....	.....	21,198	.....	18,736	.....
Plant No. 50, Wiseco field, Wise County	.....	NR	115.0	Abs.	89,396	.....	.....	60,892	.....	40,153	.....
Waskom Natural Gas Corp.											
Waskom field, Harrison County	Marshall	50.0	25.0	Abs.	.....	.....	.....	9,660	92,400	.....	[5]31,500 [6]4,200 [8]2,100 [9]8,400
West Gasoline Co.											
Hull field, Liberty County	Hull	20.0	3.0	NR	.....	.....	.....	900	.....	1,600	.....
Whelan, D. E. and R. J.											
Whelan field, Harrison County	Harleton	20.0	5.5	Abs.	.....	.....	.....	.....	.....	1,386	.....
Woodlawn Processing Corp.											
Woodlawn field, Harrison County	Marshall	105.0	80.0	Abs.	.....	.....	.....	.....	178,500	.....	.....
Young, Marshall R.											
Cook field, Shackelford County	Albany	NR	4.5	NR	.....	.....	.....	.....	.....	2,900	.....
Total††		14,263.3	11,436.5		3,464,749	465,566	1,846,469	1,292,786	7,064,326	4,222,490	587,872

*Includes heavier ends. †Remote booster stations gather gas from various fields for processing at centralized plants. ‡Represents liquids from Kittie and Clayton plants, and Karon cycling plant. §Ethane, propane, and butane mixture. ¶Raw condensate processed at Lone Star Producing Co.'s RCF plant. ‖Processes raw condensate from Lone Star Producing Co.'s Brooks and 108 plants, and from Lone Star Gas Co.'s Gordon and Pueblo plants. **Capacity figures. (For Skelly, combined stream is separated into products at the plant.) ††Normal butane total includes butanes that are not split. ‡‡Gas injection.

Company, Plant, and Location	Nearest Town	M.M.c.f. daily Capacity	M.M.c.f. daily Throughput	Gas Process Method	Production—Gallons Daily Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
Utah											
El Paso Natural Gas Co.											
Aneth field, San Juan County	Blanding	150.0	80.0	Abs.	.....	.....	.....	.....	*(302,000)	.....	.....
Mountain Fuel Supply Co.											
Clay Basin field, Daggett County		22.0	10.0	Refr.	.....	.....	.....	.....	.....	†420	.....
Total		172.0	90.0		.....	.....	.....	.....	.....	420	.....
West Virginia											
Hope Natural Gas Co.											
Hastings byproducts plant, Wetzel County	Hastings	250.0	132.0	Abs.	40,420	.....	42,301	.....	.....	41,235	.....
Pure Oil Co.											
Comfort field, Kanawha County	.....	3.0	2.8	Refr.	.....	.....	.....	.....	4,200	.....	.....
South Penn Oil Co., West Virginia Division											
Bennett field, Gilmer County	Grantsville	NR	1.1	Comp.	.....	.....	.....	.....	.....	50	.....
Blackshere field, Marion County	Mannington	NR	1.1	Comp.	.....	.....	.....	.....	.....	400	.....
Boggs field, Roane County	Spencer	NR	0.3	Comp.	.....	.....	.....	.....	.....	.....	.....
Broadwater field, Tyler County	Middlebourne	NR	0.1	Comp.	.....	.....	.....	.....	.....	10	.....
Brown field, Doddridge County	Marshville	NR	0.1	Comp.	.....	.....	.....	.....	.....	.....	.....
Clay field, Clay County	Newton	NR	0.8	Comp.	.....	.....	.....	.....	.....	1,100	.....
Coalbura field, Kanawha County	Sharon	NR	0.4	Comp.	.....	.....	.....	.....	.....	.....	.....
Coldwater field, Doddridge County	Wolf Summit	NR	0.1	Comp.	.....	.....	.....	.....	.....	.....	.....
Copley field, Lewis County	Camden	NR	0.9	Comp.	.....	.....	.....	.....	.....	225	.....
Dodd field, Kanawha County	Elkview	NR	0.7	Comp.	.....	.....	.....	.....	.....	.....	.....
Edgell field, Roane County	Clover	NR	0.5	Comp.	.....	.....	.....	.....	.....	100	.....
Fairview field, Monongalia County	Fairview	NR	1.6	Comp.	.....	.....	.....	.....	.....	650	.....
Hartley-Stephens field, Ritchie County	Brohard	NR	1.7	Comp.	.....	.....	.....	.....	.....	850	.....
Kate C. Scott field, Kanawha County	Charleston	NR	0.2	Comp.	.....	.....	.....	.....	.....	.....	.....
Liverpool field, Jackson County	Liverpool	NR	0.1	Comp.	.....	.....	.....	.....	.....	.....	.....
Lynch field, Harrison County	Wolf Summit	NR	1.5	Comp.	.....	.....	.....	.....	.....	450	.....
McElroy field, Tyler County	West Union	NR	1.0	Comp.	.....	.....	.....	.....	.....	150	.....
Metz field, Marion County	Mannington	NR	0.5	Comp.	.....	.....	.....	.....	.....	175	.....
Morgan field, Wetzel County	Smithfield	NR	1.0	Comp.	.....	.....	.....	.....	.....	900	.....
Pine Grove field, Wetzel County	Pine Grove	NR	0.8	Comp.	.....	.....	.....	.....	.....	775	.....
Prunty field, Ritchie County	Pullman	NR	0.5	Comp.	.....	.....	.....	.....	.....	10	.....
Rock Creek field, Roane County	Walton	NR	0.7	Comp.	.....	.....	.....	.....	.....	120	.....
Seckman field, Tyler County	Middlebourne	NR	0.1	Comp.	.....	.....	.....	.....	.....	.....	.....
Shinnston field, Harrison County	Shinnston	NR	0.9	Comp.	.....	.....	.....	.....	.....	100	.....
Stephens field, Ritchie County	McFarland	NR	0.2	Comp.	.....	.....	.....	.....	.....	.....	.....
Stringtown field, Tyler County	West Union	NR	0.6	Comp.	.....	.....	.....	.....	.....	800	.....
Sweeney field, Tyler County	West Union	NR	0.3	Comp.	.....	.....	.....	.....	.....	150	.....
Tanner field, Gilmer County	Grantsville	NR	1.9	Comp.	.....	.....	.....	.....	.....	350	.....
Tariff field, Roane County	Clay	NR	0.5	Comp.	.....	.....	.....	.....	.....	100	.....
Victor field, Kanawha County	Pinch	NR	1.0	Comp.	.....	.....	.....	.....	.....	750	.....
Wood, Elk Fork, and Eddy fields, Tyler County	Sistersville	NR	0.6	Comp.	.....	.....	.....	.....	.....	200	.....
United Fuel Gas Co.											
Cobb Dryer field, Kanawha County	Clendenin	85.0	45.0	Abs.	.....	.....	.....	37,000	.....	11,000	.....
Elk Dryer field, Kanawha County	Charleston	35.0	31.0	Abs.	4,100	1,000	.....	.....	.....	2,300	.....
Kenova Extraction plant, Wayne County	Kenova	170.0	112.0	Abs.	.....	.....	.....	.....	200,000	.....	.....
Total		564.8	344.6		44,520	1,000	42,301	37,000	204,200	62,950	.....

*Products separated at Wingate, N. M., plant. †Includes heavier ends.

Company, Plant, and Location	Nearest Town	M.M.c.f. daily Capacity	M.M.c.f. daily Throughput	Gas Process Method	Production—Gallons Daily Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
Wyoming											
Cabot Carbon Co.											
Glenrock field, Converse County	Glenrock	9.0	6.5	Refr.	21,599	.....	7,802	.....	.....	13,991	.....
Continental Oil Co.											
Sussex field, Johnson County	Linch	15.0	16.2	Refr.	15,080	.....	8,880	.....	.....	6,160	.....
El Paso Natural Gas Co.											
Opal field, Lincoln County	Opal	250.0	158.0	Abs.	56,800	.....	21,600	.....	51,600	.....	.....
Mobil Oil Co.											
Big Horn field, Big Horn County*	Manderson	15.0	7.0	NR	.....	.....	.....	100	.....	1,500	.....
Mountain Fuel Supply Co.											
Church Buttes field	Uinta	100.0	55.0	Abs.	.....	.....	.....	.....	.....	†1,000	.....
Ohio Oil Co.											
Lance Creek field, Niobrara County	Lance Creek	5.0	3.2	Abs.	6,172	.....	5,503	.....	.....	6,450	.....
McFadden plant, Rock River field, Carbon County	Rock River	2.5	1.6	Abs.	2,855	.....	2,563	.....	.....	1,738	.....
Pan American Petroleum Corp.											
Beaver Creek field, Fremont County	Riverton	62.0	24.0	Abs.	7,476	.....	6,594	.....	.....	5,502	.....
Elk Basin field, Park County, Wyoming, and Carbon County, Montana	Elk Basin	12.0	13.0	Abs.	16,464	.....	24,612	.....	.....	28,560	.....
Pure Oil Co.											
Worland field, Washakie County	.....	60.0	53.0	Abs.	34,000	6,000	.....	.....	32,000	.....	.....
Sinclair Oil & Gas Co.											
Sweetwater County	Bairoil	9.0	9.0	Comp.	.....	.....	.....	.....	.....	10,000	.....
Total‡		539.5	346.5		160,446	6,000	77,554	100	83,600	74,901	.....

*Big Horn will be shut down in May 1960. †Includes heavier ends. ‡Normal butane total includes butanes that are not split.

Journal Survey of Cycling Plants in the United States

State Capacities as of January 1, 1960, and Average Production in 1959

State—	No. plants	M.M.c.f. Daily Capacity	M.M.c.f. Daily Throughput	Production—Gallons Daily Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other	Total Products
Arkansas	2	78.5	56.2	18,364	8,203	11,717	3,936	.....	30,705	.....	72,925
California	4	342	286.5	88,382	11,912	48,009	23,000	.....	220,792	.....	392,095
Colorado	1	3	1	800	.....	.....	1,200	.....	.....	.....	2,000
Louisiana	13	1,176.5	1,029.2	303,150	29,000	136,908	161,073	.....	1,288,964	291,902	2,210,997
Mississippi	1	200	200	13,000	.....	.....	.....	.....	37,000	.....	50,000
Oklahoma	3	309.7	277	90,300	.....	2,500	18,600	.....	165,150	.....	276,550
Texas	26	2,724	2,202.4	495,175	234,093	237,179	50,789	.....	1,400,179	632,309	3,049,724
West Virginia	1	25	20	6,000	.....	5,000	.....	.....	6,000	.....	17,000
Wyoming	1	25	23	19,236	.....	42,966	.....	.....	46,326	.....	108,528
Total	52	4,883.7	4,095.3	1,034,407	283,208	484,279	258,598	.....	3,195,116	924,211	6,179,819

ETHANE RECOVERY IN YOUR FUTURE ?

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the engineering company with ethane experience behind it.

Although ethane recovery is still in its infancy, Delta Engineering Corporation has the design, engineering, and construction experience to produce a profit-making plant for you at minimum cost. The Hamilton and CVOC plants shown on this page are indicative of the creative thinking that goes into every performance-proved project engineered by Delta. Whether ethane recovery is in your future in the form of a new plant or as an addition to your present facilities, consult with Delta first—the engineering contractors with ethane experience behind them.

HAMILTON PLANT

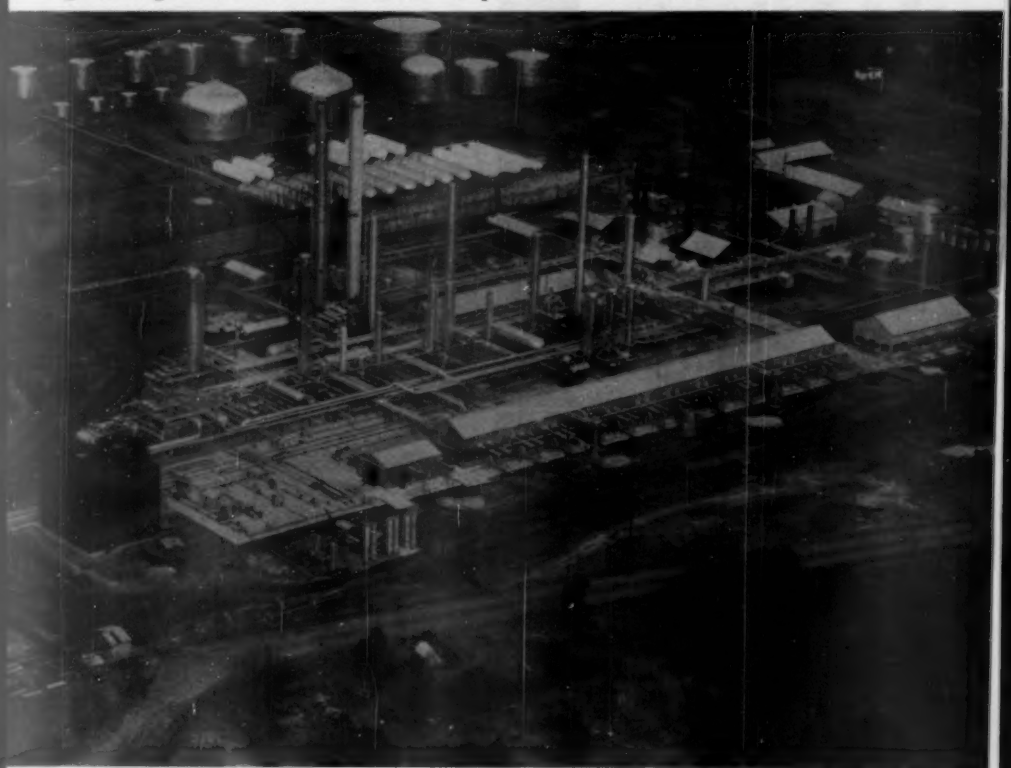
Columbia, Ark. Constructed for Arkansas-Louisiana Chemical Corporation to process a maximum of 400 million cubic feet of gas per day and produce 85,000 gallons per day of ethane. Facilities are designed to double ethane production in the future.

Four 100 ft. inlet gas exchanger trains with absorbers.

5,000 h.p. steam turbine driven centrifugal propane refrigerant compressor installation.

Centralized control room—showing process controllers and alarm system annunciator panels.

DESIGNING ENGINEERING DELTA CONSTRUCTION



COTTON VALLEY OPERATORS COMMITTEE PLANT, WEBSTER PARISH, LA. This recycling plant was modified to process up to 240 million cubic feet of gas per day, and to recover 230,000 gallons of ethane per day. It utilizes a refrigerated, low molecular weight oil absorption process.

DELTA ENGINEERING CORPORATION

ENGINEERING CONTRACTORS

2121 SAN FELIPE ROAD • P. O. BOX 13256 • HOUSTON, TEXAS

Cycling-Plant Capacities as of January 1, 1960, and Average Production in 1959

Products listed in the last column are identified by numbers:

1. Ethane
2. Ethane mix
3. Isopentane
4. Normal pentane
5. Upgraded motor fuel
6. Solvent naphtha
7. Jet fuel
8. Diesel
9. Kerosine
10. Light residuum
11. Diesel, kerosine, and bottoms

NR means not reported.

Arkansas

Company, Plant, and Location	Nearest Town	M.M.c.f. daily		Gas	Production—Gallons Daily						
		Capacity	Throughput	Process Method	Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
Lion Oil Co.											
Schuler Unit plant, Union County	El Dorado	26.0	15.0	Abs.	1,611	.....	.....	3,936	.....	6,623	.....
McKamie Gas Cleaning Co.											
Lerch plant, McKamie-Patton field, Lafayette County	Stamps	52.5	41.2	Abs.	16,753	8,203	11,717	.....	.....	24,082	.....
Total		78.5	56.2		18,364	8,203	11,717	3,936	.....	30,705	.....

California

Belridge Oil Co.											
Belridge field, Kern County	McKittrick	80.0	62.0	Abs.	14,400	2,800	.....	.....	.....	26,600	.....
Gulf Oil Corp.											
Paloma field, Kern County	Bakersfield	150.0	128.0	Abs.	48,232	.....	37,466	.....	.....	*144,443	.....
Ohio Oil Co.											
South Coles Levee field, Kern County	Bakersfield	80.0	76.5	Abs.	4,750	9,112	10,543	.....	.....	30,749	.....
Union Oil Co. of California											
Coalinga Nose field, Fresno County	Coalinga	32.0	20.0	Abs.	21,000	.....	.....	23,000	.....	19,000	.....
Total		342.0	286.5		88,382	11,912	48,009	23,000	.....	220,792	.....

*Includes heavier ends.

Colorado

Ginther Gasoline Plants, N. C.											
Leader field, Adams County	Last Chance	3.0	1.0	Abs.	800	.....	.....	1,200	.....	.....	.....

Louisiana

Acadia Corp.											
Several fields in Acadia Parish	Crowley	130.0	110.0	Abs.	27,500	.....	25,000	.....	.....	70,000	[8]30,000
California Co.											
Lake St. John field, Tensas Parish	Farraday	125.0	125.0	Abs.	36,000	.....	.....	.....	.....	54,000	.....
Cotton Valley Operators Committee											
Cotton Valley field, Webster Parish	Cotton Valley	220.0	158.0	Abs.	130,000	29,000	40,500	.....	.....	84,000	[1]100,000 [7]71,000 [8]15,000 [9]1,200 [10]31,000

Company, Plant, and Location	Nearest Town	M.M.c.f. daily		Gas	Production—Gallons Daily						
		Capacity	Throughput	Process Method	Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
LOUISIANA (Continued)											
Gulf Oil Corp.											
Krotz Springs field, St. Landry Parish	Krotz Springs	100.0	60.0	Abs.	45,582	.....	22,625	.....	.....	*183,101	.....
Haynesville Operators Committee											
Pettit field, Claiborne Parish	Haynesville	22.5	17.2	Abs.	2,066	.....	1,117	.....	.....	12,817	.....
Mobil Oil Co.											
Opelousas field, St. Landry Parish	Opelousas	23.0	20.9	Refr.	.....	.....	.....	9,055	.....	*57,332	.....
Pan American Petroleum Corp.											
South Jennings field, Jefferson Davis Parish	Jennings	55.0	46.0	Abs.	.....	.....	.....	5,418	.....	28,476	[11]12,642
Sohio Petroleum Co.											
Washington field, St. Landry Parish	Opelousas	42.0	42.0	Abs.	26,000	.....	24,000	.....	.....	.....	.....
Sunray Mid-Continent Oil Co.											
Benton field, Bossier Parish	Benton	50.0	44.5	NR	14,723	.....	9,258	.....	.....	23,430	†31,060
Northwest Branch field, Acadia Parish	Church Point	24.0	18.6	NR	11,119	.....	6,408	.....	.....	56,000	.....
South Sarepta field, Bossier Parish	Sarepta	20.0	22.0	NR	10,160	.....	8,000	.....	.....	57,808	.....
Texaco Inc.‡											
Bateman Lake field, St. Mary Parish	Berwick	145.0	NR	Abs.	.....	.....	.....	8,000	.....	135,000	.....
Erath field, Vermilion Parish	Erath	220.0	NR	Abs.	.....	.....	.....	138,600	.....	*533,000	.....
Total§		1,176.5	1,029.2		303,150	29,000	136,908	161,073	.....	1,288,964	291,902

*Includes heavier ends. †Type not reported. ‡Capacity figures. §Normal butane total includes butanes that are not split.

Mississippi

California Co.											
Cranfield field, Adams County	Washington	200.0	200.0	Abs.	13,000	.....	.....	.....	.....	37,000	.....

Oklahoma

Keener Oil Co.											
Bartlett plant, Custer County	Butler	35.0	24.0	Abs.	.....	.....	.....	18,600	.....	550	.....
Mobil Oil Co.											
Chitwood field, Grady County	Chickasha	24.7	11.0	Abs.	2,300	.....	.....	.....	.....	3,600	.....
Shell Oil Co.											
Elk City-Hoxbar Unit, Beckham County	Elk City	250.0	242.0	Abs.	88,000	.....	2,500	.....	.....	161,000	.....
Total		309.7	277.0		90,300	.....	2,500	18,600	.....	165,150	.....

Texas

Champlin Oil & Refining Co.											
Coastal plant, Stratton-Agua Dulce field, Nueces County	Agua Dulce	120.0	60.0	Abs.	11,046	6,000	6,000	.....	.....	35,532	[1]21,798
Gulf Plains plant, Stratton-Agua Dulce field, Nueces County	Bishop	220.0	235.0	Abs. & Refr.	83,080	26,880	24,024	.....	.....	110,712	[1]76,440
Distillate Production Corp.											
North Houston field, Harris County	Houston	75.0	50.0	Abs.	15,000	5,000	5,000	.....	.....	18,500	[8]400
Francitas Gas Co.											
Francitas field, Jackson County	Blessing	40.0	20.0	Abs.	.....	.....	.....	5,250	.....	13,650	[8]2,100
Gasoline Production Division, H. B. Zachry Co.											
Tuleta field, Bee County	Pettus	40.0	17.0	Abs.	.....	.....	.....	6,000	.....	.....	[5]18,000 [6]550 [9]1,200
Goliad Corp.*											
Karon Remote Absorber plant, Live Oak County	Oakville	28.0	27.0	Abs.	.....	.....	.....	.....	.....	.....	.....
Humble Oil & Refining Co., Humble Division											
Julian field, Kenedy County	Encino	9.0	8.6	Refr.	.....	.....	.....	.....	.....	†42,300	.....
Katy field, Waller County	Katy	555.0	519.8	Abs.	.....	77,200	48,600	.....	.....	†440,900	[2]409,800

Company, Plant, and Location*	Nearest Town	M.M.c.f. daily Capacity	M.M.c.f. daily Throughput	Gas Process Method	Production—Gallons Daily Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
TEXAS (Continued)											
La Gloria Oil & Gas Co.											
La Gloria field, Jim Wells and Brooks counties	Falfurrias	330.0	297.0	Abs.	61,500	27,500	30,000	.....	.....	133,000	[8]1,570 [9]21,000
Lone Star Producing Co.											
Carthage plant, Panola County	Carthage	100.0	30.0	Abs.	.....	.....	.....	.....	.....	†20,204	[9]137
Chapel Hill plant, Smith County	Tyler	45.0	38.0	Abs.	9,216	146	.....	.....	.....	†24,288	.....
Fort Chadbourne plant, Coke County	Bronte	30.0	28.0	Abs.	20.600	5,233	16,016	.....	.....	†9,838	[3]2,553
Opelika plant, Henderson County	Murchison	85.0	82.0	Abs.	.....	.....	9,559	.....	.....	†46,015	.....
Luling Oil & Gas Co.											
Glen Cove plant, Coleman County	Glen Cove	5.0	5.0	Abs.	.....	.....	.....	4,335	.....	2,000	.....
Mobil Oil Co.											
Seeligson field, Jim Wells County	Premont	292.0	220.0	Abs.	80,000	30,000	20,000	.....	.....	130,000	[1]2.5 M.M.c.f. [9]1,000 [11]9,000
Pan American Petroleum Corp.											
Burnell-North Pettus field, Karnes, Bee, and Goliad counties	Pettus	187.0	177.0	Abs.	49,308	17,892	7,518	14,112	.....	118,104	[11]11,298
Plomo Co.											
Brayton field, Nueces County	Robstown	60.0	41.5	Abs.	10,130	3,798	2,750	.....	.....	23,800	[2]10,000
Plymouth Oil Co.											
Plymouth field, San Patricio County	Sinton	65.0	42.0	Abs.	3,606	.....	.....	5,092	.....	11,909	[5]16,021 [7]4,054 [8]12,595
Runnels Gas Products Corp. (subsidiary of Union Texas Natural Gas Corp.)											
Cree-Sykes field, Runnels County	Ballinger	30.0	22.0	Refr.	22,000	.....	13,000	.....	.....	15,000	.....
Shell Oil Co.											
Sheridan field, Colorado County	Sheridan	110.0	104.0	Abs.	49,000	16,000	21,000	.....	.....	59,000	[3]9,600
Sinclair Oil & Gas Co.											
Silsbee field, Hardin County	Silsbee	58.0	39.0	Abs.	23,000	12,000	12,000	.....	.....	36,000	.....
South Hampton field, Hardin County	Silsbee	25.0	22.0	Abs.	11,000	.....	10,000	.....	.....	22,000	.....
South-Tex Corp.											
Agua Dulce field, Nueces County	Banquete	80.0	50.0	Abs.	8,000	.....	.....	10,000	.....	21,000	[9]1,000
Superior Oil Co.											
Lake Creek field, Montgomery County‡	.....	55.0	15.0	Abs.	26,816	6,444	7,367	.....	.....	†43,174	.....
Tidewater Oil Co.											
Long Lake field, Anderson County	Palestine	30.0	10.0	Abs.	2,000	.....	.....	6,000	.....	9,500	.....
Trinity Gas Corp.											
Sejita field, Duval County	Falfurrias	50.0	42.5	Abs.	9,873	.....	4,345	.....	.....	†13,753	[8]1,122 [9]1,071
Total§		2,724.0	2,202.4		495,175	234,093	237,179	50,789	.....	1,400,179	632,309

*See natural-gasoline plant survey for liquid products from Goliad plants in Texas. †Includes heavier ends. ‡Partially a cycling operation. The Ramsey plant listed in the natural-gasoline plant survey and the Lake Creek plant operate as one unit having separate gas outlets. §Normal butane total includes butanes that are not split.

West Virginia

Owens, Libbey-Owens Gas Department											
South Malden field, Kanawha County	Charleston	25.0	20.0	Abs.	6,000	.....	5,000	.....	.....	6,000	.....

Wyoming

Pan American Petroleum Corp.											
Salk Creek field, Natrona County	Midwest	25.0	23.0	Abs.	19,236	.....	42,966	.....	.....	46,326	.....

Journal Survey of Field-Processing Plants in Canada

Province Capacities as of January 1, 1960, and Average Production in 1959

Province—	No. plants	M.M.c.f. Daily Capacity	M.M.c.f. Daily Throughput	Production—Gallons Daily Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other	Total Products
Alberta	19	1,135	759.9	134,705	11,900	98,850	71,085	10,080	434,399	.....	761,019
British Columbia	1	300	200	10,000	10,000	10,000	.....	.....	70,000	35,350	135,350
Ontario	1	15	9	.....	.....	.....	.....	.....	.....	.....	.....
Saskatchewan	4	104.7	75.5	57,110	7,200	24,100	.....	.....	12,210	.....	100,620
Total	25	1,554.7	1,044.4	201,815	29,100	132,950	71,085	10,080	516,609	35,350	996,989

Plant Capacities as of January 1, 1960, and Average Production in 1959

Note: Legend for identifying products is found at beginning of U.S. natural-gasoline-plant survey.

Company, Plant, and Location	Nearest Town	M.M.c.f. daily Capacity	M.M.c.f. daily Throughput	Gas Process Method	Production—Gallons Daily Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
Alberta											
Ajax Processors, Ltd.											
St. Albert field	Edmonton	25.0	24.0	Abs.	.....	.....	.....	.....	.....	4,600	.....
Anglo American Exploration, Ltd.											
Hartell field	.....	10.0	4.5	Abs.	.....	900	.....	.....	.....	3,800	.....
British American Oil Co., Ltd.											
Nevis plant, Nevis, Fenn, Big Valley, and Stettler fields	Stettler	35.0	20.0	Refr.	9,000	.....	8,000	.....	.....	*9,000	.....
Pincher Creek field	Pincher Creek	204.0	148.0	Abs.	13,000	.....	23,000	.....	.....	*127,000	.....
California Standard Co.											
Princess field	Brooks	12.0	6.0	Ads.	.....	.....	.....	.....	.....	*840	.....
Nevis Operators Committee plant, Nevis field	Stettler	43.0	25.0	Abs., Refr. & Comp.	.....	.....	.....	.....	.....	*16,400	.....
Canadian Fina Oil, Ltd.											
Samson plant	Wetaskiwin	20.0	20.0	NR	.....	.....	.....	.....	5,880	.....	.....
Windfall Pilot plant†	Whitecourt	30.0	30.0	Stage separation	.....	.....	.....	.....	.....	*105,000	.....
Goliad Oil & Gas Co.											
Pembina field	Edmonton	‡90.0	‡70.0	Refr.	60,200	11,000	33,900	.....	.....	37,500	.....
Home Oil Co., Ltd.											
Carstairs plant	.....	75.0	38.0	Refr.	.....	.....	.....	.....	.....	42,000	.....
Hudson's Bay Oil & Gas Co., Ltd.											
H. B. Delhi Cessford plant	Calgary	125.0	65.0	Refr.	.....	.....	.....	.....	.....	4,914	.....
Imperial Oil Ltd.											
Golden Spike plant	.....	21.0	8.9	(No products listed)							
Leduc plant No. 1	Devon	32.0	26.0	Refr.	29,400	.....	24,150	.....	.....	14,000	.....
Redwater plant	Redwater	10.0	5.7	Refr.	11,200	.....	9,800	.....	.....	4,550	.....
Mid-Western Industrial Processors, Ltd.											
Alexander field	Edmonton	55.0	33.0	Refr.	.....	.....	.....	.....	.....	5,880	.....
Progas, Ltd.											
Acheson field	.....	5.0	.....	(Products not reported)							

Company, Plant, and Location	Nearest Town	M.M.c.f. daily Capacity	M.M.c.f. daily Throughput	Gas Process Method	Production—Gallons Daily Propane	Isobutane	Normal Butane	LPG Mix	Combined Gaso.-LPG	Natural Gasoline	Other
ALBERTA (Continued)											
Provo Gas Producers, Ltd.											
Consort plant, Prevost field	Calgary	90.0	50.0	Ads. & Abs.	.....	.....	.....	.....	4,200	.....	.....
Royalite Oil Co., Ltd.											
Turner Valley field†	.....	100.0	47.5	Abs. & Refr.	11,905	.....	.....	.....	.....	40,915	.....
Shell Oil Co. of Canada, Ltd.											
Jumping Pound plant	Cochrane	90.0	90.0	(No products reported)							
Texaco Exploration Co.§											
Bonnie Glen	.....	30.0	NR	NR	.....	.....	.....	71,000	.....	18,000	.....
Texas Gulf Sulphur Co.											
Okotoks Unit	Calgary	30.0	12.0	(No products reported)							
Western Leaseholds, Ltd.											
Hobbema	Wetaskiwin	3.0	1.3	Refr.	.....	.....	.....	85	.....	.....	.....
Total¶		1,135.0	759.9		134,705	11,900	98,850	71,085	10,080	434,399	.....
Phillips Petroleum Co. (formerly listed as Pacific Petroleums, Ltd.)											
Taylor Flats	.....	300.0	200.0	Abs.	10,000	10,000	10,000	.....	.....	70,000	‡350 ‡35,000
Ontario											
Union Gas Co. of Canada, Ltd.											
Port Alma plant, Tilbury field, Kent County	Chatham	15.0	9.0	(Gas purification and dehydration)							
Saskatchewan											
Imperial Oil Ltd.*											
Nottingham Gas, Ltd., plant	Nottingham	8.5	5.3	Refr.	9,110	.....	4,900	.....	.....	3,150	.....
Smiley Gas Conservation, Ltd., plant	Smiley	3.2	3.2	Refr.	.....	.....	.....	.....	.....	2,100	.....
Saskatchewan Power Corp.											
Coleville field	.....	60.0	37.0	Abs.	.....	.....	.....	.....	.....	5,400	.....
Steelman Gas, Ltd.											
Steelman field	Estevan	33.0	30.0	NR	48,000	7,200	19,200	.....	.....	1,560	.....
Total		104.7	75.5		57,110	7,200	24,100	.....	.....	12,210	.....

*Includes heavier ends. †Cycling operation. ‡Processed in eight satellite stations which deliver raw make to fractionation plant. §1959 Journal survey figures. ¶Normal butane total includes butanes that are not split.

*All figures are 1960 forecast.

Field-Processing-Plant Projects in U.S. and Canada

Following is a list of plants and expansions under way or planned in the United States and Canada as of January 1, 1960.

The report includes 37 projects in the United States and 4 in Canada.

A

Acadia Corp. is building new fraction and reformation facilities at its existing plant in Acadia Parish, Louisiana, with completion scheduled September 1, 1960. Liquid production will be 420,000 gal. daily. **Hudson Engineering Corp.**, Houston, has contract.

Amarillo Oil Co. is building a new plant in East Panhandle field, Gray County, near Pampa, Tex., with capacity of 60 M.M.c.f. Production will include 59,000 gal. daily. **Dresser Engineering Co.**, Tulsa, has contract, with completion set for May 1960.

Anchor Gasoline Corp. was scheduled to complete its $400,000 Tabasco plant in Hidalgo County near Mission, Tex., in April 1960. Capacity is 25 M.M.c.f. daily, and production 17,000 gal. daily. **Pierce Construction Co.**, Tulsa, is contractor. Process method is absorption.

Antelope Gas Products Co. will start construction at its Banner plant near Kimball in Banner County, Nebraska, in May 1960. Capacity will be 9.6 M.M.c.f. daily and production 70,000 gal. daily. Contractor is **O. L. Olsen Co., Inc.**, Houston, and completion is set for August 1, 1960. Process method is absorption.

Atlantic Refining Co. will add 7 M.M.c.f. compression capacity to its plant in Block 31, Crane County, Texas. Completion is set for July 1960. Existing capacity is 61 M.M.c.f. daily.

B

British American Oil Co., Ltd., is building Canada's largest field-processing plant at Homeglen-Rimbey and Westerose South fields near the town of Rimbey, about 110 miles north of Calgary. Capacity will be 326 M.M.c.f. daily when completed November 1, 1960, by **Poole-Pritchard Canadian, Ltd.**, Calgary, Alta. Products will include 68,000 gal. daily of C_3, 98,000 gal. per day of C_4, and 325,000 gal. per day of C_{5+}.

C

Cabot Carbon Co. will remodel its Estes plant in Ward County, Texas, with completion scheduled December 15, 1960. Capacity will be 25 M.M.c.f. daily, with liquid recovery of 37,500 gal. daily.

The company's Walton plant in Eastland County, Texas, will also be remodeled, with completion September 30, 1960. Capacity will be 38 M.M.c.f. daily, with liquid recovery of 57,000 gal. daily.

Canadian Fina Oil, Ltd., plans to expand its Windfall Pilot plant at Whitecourt, Alta., with capacity of 180 M.M.c.f. per day and production of 600,000 gal. per day. Completion is set for 1962.

Canadian Oil Companies, Ltd., will be operator for Innisfail Operators' Committee of a new plant in Innisfail field, Alberta. The plant will contain crude-stabilization, gas-processing, and sulfur-recovery facilities. Capacity for dry gas will reportedly be 8.7 M.M.c.f. daily, with production of about 6,400 gal. of natural-gas liquids daily.

Continental Oil Co. will add absorption-refrigeration facilities at its Louisiana Gas System plant in Calcasieu Parish, near Lake Charles, La. Capacity will be 150 M.M.c.f. daily, with average daily production ranging from 93,000 to 158,000 gal. Completion is set for January 1, 1961. The plant will have 50% ethane recovery, and recovery of 100% of propanes plus.

At KMA field in Wichita County, Texas, Continental will add 7.5 M.M.c.f. daily capacity in a modernization program at the existing 11.2-M.M.c.f. plant. Completion was scheduled this spring.

E

El Paso Natural Gas Co. will start construction in May on a new plant in Brown-Bassett field, Terrell County, Texas, using the **Fluor Corp., Ltd.**, solvent CO_2 removal process. The new treating facility will produce 100,000 M.c.f. of residue gas daily. Completion by Fluor is expected in December 1960. This will be the first gas-treating facility to use the process, which applies an organic solvent to physically absorb high concentrations of CO_2 from natural gas. Natural gas from Brown-Bassett field contains up to 53% CO_2.

G

Goliad Corp. is building a $12-million gas processing and liquid-recovery system in Vermilion Parish, about 9 miles south of Kaplan, La. The plant, with capacity of 450 M.M.c.f. daily, will extract 295,000 gal. of liquids daily. **Fluor Corp., Ltd.**, Los Angeles, and **Brown & Root, Inc.**, Houston, have contracts. Process method will be refrigeration. Completion is expected in October 1960.

Graridge Corp. recently completed expansion of its Plant No. 2 in Eastland field, Eastland County, Texas. New facilities will have capacity of 18 M.M.c.f. daily and will extract 15,000 gal. daily, using the refrigeration method. **Maloney-Crawford** was contractor.

H

Humble Oil & Refining Co. will complete its 800-M.M.c.f. daily King Ranch plant in Kleberg County, Texas, late in 1960. The absorption-type plant is 15 miles south of Kingsville and is the largest of its type in America. Liquids extraction will average about 1,176,000 gal. daily. **Hudson Engineering Corp.**, Houston, has the contract. Cycling facilities will be included.

Hunt Oil Co. is building a plant with 25 M.M.c.f. capacity at Franks field near Alta Loma in Galveston County, Texas. It will extract 33,000 gal. of deethanized product daily. Process method is refrigeration-absorption. **Hudson Engineering Corp.**, Houston, has the contract, and completion is expected August 1, 1960.

L

La Gloria Oil & Gas Co. is building a plant with 176 M.M.c.f. daily capacity at Rayne field, Acadia Parish, Louisiana. The low temperature separation and absorption plant will extract 195,000 gal. of products daily after completion June 1, 1960. **Brown & Root, Inc.**, Houston, has contract.

M

Mesquite Gas Products, Inc., was scheduled to complete its new Davis plant in Upton County near Odessa, Tex., this spring. Capacity will be 6 M.M.c.f. daily with initial throughput of 3 M.M.c.f. daily. Process method will be absorption, and production will include 25,500 gal. of propane, mixed butane, and natural gasoline daily.

N

NGL Corp. will complete a new processing plant on the Sabine River south of Orange, Tex., probably in April 1961. The plant will process natural-gas condensate, distillate, and natural gasoline, and will turn out 98-octane gasoline initially. Described as a 20,000-bbl. per day plant, it will have cat reforming and catalytic hydrogen treating.

Northern Natural Gas Co. will double capacity of its Spearman plant in Ochiltree County, Texas, to 200 M.M.c.f. daily. The additional capacity, using the refrigeration method, will result in 16,000 gal. daily of products. **Dresser Engineering Co.**, Tulsa, has the contract, and completion is expected in October 1960.

The FPC has reported that Northern

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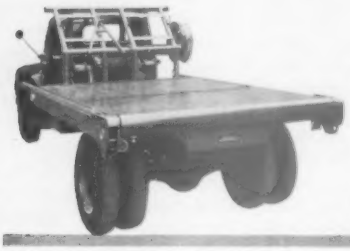

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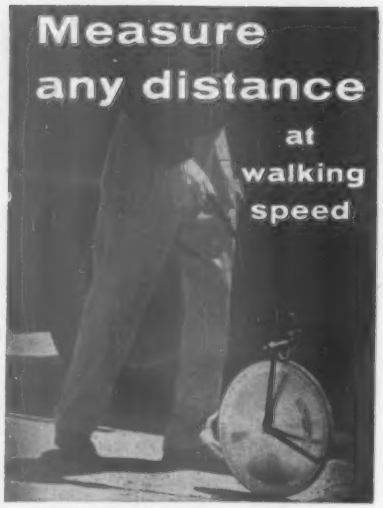

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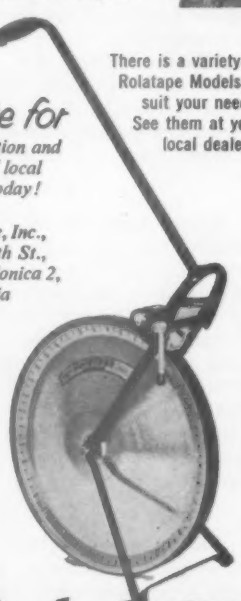

Rolatape
Measuring Wheels

Natural Gas Co. plans to build a 50-M.M.c.f. dehydration and hydrocarbon extraction plant in Glick field, Kansas.

O

Ohio Oil Co. is nearing completion at its 25-M.M.c.f. daily plant in Hillsdale County, Michigan. The plant will serve Scipio, Pulaski, and Albion fields, with initial production of 40,000 gal. daily. **Stearns-Roger Manufacturing Co.,** Denver, is contractor, and completion is expected June 1, 1960.

P

Pan American Petroleum Corp. is expanding its Old Ocean field plant in Brazoria County, Texas, from present 350 M.M.c.f. daily to 570 M.M.c.f. daily. The plant will use refrigeration and absorption and will extract 650,000 gal. of products daily, compared with present production of about 287,000 gal. daily. **Brown & Root, Inc.,** Houston, has contract, with completion set for September 1, 1960.

The company will start operations at its new 18-M.M.c.f. daily plant in Empire-Abo field, Eddy County, New Mexico, in June 1960. Using the refrigeration process method, the plant will extract 64,000 gal. of products daily. **O. L. Olsen Co., Inc.,** Houston, has the contract.

Phillips Petroleum Co. is building a plant southeast of Artesia, N. M., for processing gas from Atoka, Dayton, Abo, Empire-Abo, East Millman, Artesia, Red Lake, and other fields for pipeline delivery to Phillips' processing centers near Borger and Sweeny, Tex. Initial capacity will be 35 M.M.c.f. daily. Liquid recovery will be about 100,000 gal. daily.

Phillips is expanding its existing 300-M.M.c.f. per day plant at Taylor, B. C., to include a new crude unit, cat cracker, and HF alkylation unit. Contractor is **Stearns-Roger Manufacturing Co.,** Denver., and completion is set for August 1960.

R

Runnels Gas Products Corp. is expanding its Eunice plant in Louisiana from the existing 450 M.M.c.f. daily to 800 M.M.c.f.d. The plant will extract 850,000 gal. of products daily after completion January 12, 1961. **Fluor Corp., Ltd.,** Los Angeles, has contract for the low-temperature, low-molecular-weight, oil-absorption-type plant.

S

Shell Oil Co. was scheduled to complete a cycling and processing plant at Weeks Island field, New Iberia Parish, Louisiana, this spring. Capacity is 120 M.M.c.f. daily, with liquid recovery of 72,000 gal. per day of volatiles and 175,000 gal. daily of distillate. Contract held by **Farnsworth & Chambers Co., Inc.,** Houston.

Skelly Oil Co. and **Sinclair Oil & Gas Co.** were scheduled to complete a new plant to serve Maljamar and Loco Hills fields in Eddy County, New Mexico, in the spring of 1960. Capacity will be 20 M.M.c.f. daily with liquid recovery of 48,000 gal. daily.

Southern Union Gas Co. was scheduled to complete a revision of its Lybrook plant in Rio Arriba County, New Mexico, early in 1960: Liquid recovery at the revamped plant is 52,800 gal. daily. Capacity is 60 M.M.c.f. daily.

Southwest Gas Producing Co., Inc., will build a plant in Calhoun field, Ouachita Parish, Louisiana, with capacity of 75 M.M.c.f. daily and liquid recovery of 140,000 gal. daily. Completion by **Fish Engineering Corp.,** Houston, is scheduled September 1, 1960. Process method at the $1,500,000 project will be refrigeration-absorption.

Sunray Mid-Continent Oil Co. will build a new plant in Garza County, Texas, with 5 M.M.c.f. per day capacity and liquid recovery of 43,000 gal. daily. Completion by **Dresser Engineering Co.,** Tulsa, is expected in July 1960. Process method is refrigeration-absorption.

Sunray's Criner plant capacity in McClain County, Oklahoma, will be increased from present 8 M.M.c.f. per day to 19 M.M.c.f. daily in July 1960, with total liquid recovery of 40,000 gal. daily. Process method is refrigeration-absorption.

Sunray will add 5-M.M.c.f. per day capacity to its 55-M.M.c.f. Benton field cycling plant in Bossier Parish, Louisiana. Additional product recovery will be 30,000 gal. daily. Completion by **Weatherby Engineering Co.,** Houston, is expected July 1, 1960.

At Sunray's Carancahua Bay plant in Jackson County, Texas, capacity will be increased from 30 M.M.c.f. daily to 46 M.M.c.f., with completion expected by October 1960.

T

Texaco Inc. plans to build a plant in South Kermit field, Winkler County, Texas, with capacity of 7 M.M.c.f. daily and liquid recovery of 12,000 gal. daily. Completion set for fall 1960.

At Lamesa field in Dawson County, Texas, the company will build a 12-M.M.c.f.-daily plant, with completion in summer 1960.

Texas Gulf Producing Co. plans to add condensate fractionation at its Headlee plant in Ector County, Texas. Capacity will be 40 M.M.c.f. daily and liquid recovery of 80,000 gal. daily. The process method will be absorption, and completion is scheduled January 1, 1961.

Tidewater Oil Co. was nearing completion at its new plant in Hollywood-Houma field, Terrebonne Parish, Louisiana. Capacity will be 75 M.M.c.f. daily and liquid recovery 45,000 gal. daily. Process method is refrigeration-absorption. Completion by **O. L. Olsen Co., Inc.** Houston, is expected May 10, 1960.

At New Hope field in Franklin County, Texas, Tidewater will complete a new plant with capacity of 50 M.M.c.f. daily in August 1960. Liquid recovery will be 386,000 gal. daily. Process method will be absorption. Brown & Root, Inc., Houston, is contractor. The plant will include sulfur-recovery unit.

Computer ups ethylene plants throughput

CONTROL of a natural-gas-cracking furnace using a general-purpose digital computer has resulted in a 10% increase in throughput at Phillips Chemical Co.'s Sweeny, Tex., ethylene plant.

Success of the recently completed experiment, which included closed-loop computer control, was announced jointly by Phillips Petroleum Co., parent company of Phillips Chemical, and Autonetics, a division of North American Aviation, Inc.

Phillips developed the mathematical model for the process, built special data-scanning equipment to provide process information to the computer, and performed the major part of the programing. Autonetics gave technical assistance and installed and coded the Recomp computer.

How it worked . . . The computer was connected directly to a 30-channel data scanner which converted analog signals from measuring elements to digital signals. All measurements of temperature, pressure, and flow were sampled in sequence, on demand from the computer.

From this process information the computer calculated furnace operating conditions and yields which could not be obtained by other measurements in a reasonable length of time. These values were compared with operating conditions and yields. The computer then calculated and printed a new set of guides which the operator used in controlling the unit.

The computer was used for on-line control during part of the experimental program. It used the calculated operating guides to adjust process set points automatically. Result was stable, closed-loop, computer control.

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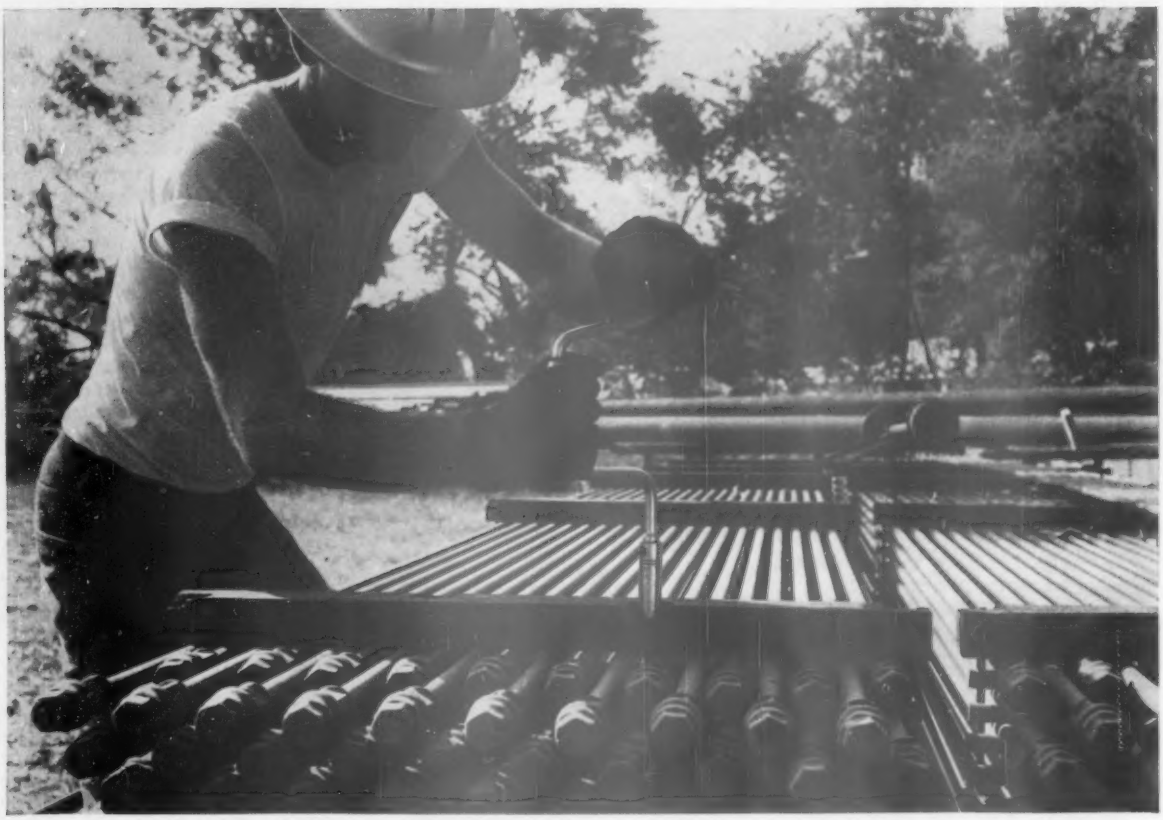

Socket wrench easily opens a bundle of Bethlehem sucker rods, tightly packed as a unit to prevent damage in transit. Special spacers separate and protect each rod.

Meticulous

That's the word to describe the way each Bethlehem sucker rod is guided with care through the entire cycle from manufacture to bundling and shipping.

Bethlehem also makes a complete line of sucker rod accessories. For further information on quality-controlled Bethlehem sucker rods, contact your nearby Bethlehem distributor. He's ready to serve you.

These four grades cover any pumping needs.

Rod	Type	Heat-Treatment	Yield Point psi		Tensile Strength psi	
			Min.	Av.	Min.	Av.
X2	Carbon-Manganese	Normalized	65,000	72,000	93,000	100,000
X Mayari	Nickel-Chromium	Normalized	60,000	65,000	90,000	95,000
46	Nickel-Molybdenum	Normalized and Tempered	67,000	75,000	82,000	90,000
43	Nickel-Chromium-Molybdenum	Normalized and Tempered	100,000	110,000	120,000	130,000

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BETHLEHEM STEEL

Geological formations suitable for construction of these underground storage caverns are found in many parts of the U.S. and broad areas have been tentatively classified as favorable or unfavorable in . . .

Planning for mined underground LPG storage

BY S. E. SCISSON
Fenix & Scisson, Inc.

MINED underground caverns for the storage of LPG have been well accepted by industry since their development 10 years ago. There are now 29 storage caverns either completed or under construction in this country with a total capacity of nearly 5 million barrels. They are located in 9 states, and 15 different companies are either owners or part owners of such facilities.

Geological formations suitable for construction of these underground storage caverns are found in many parts of the U. S. and—where the principal requirements can be met—this type of storage can be built for approximately $3 to $4 per barrel of capacity. But before a project of this nature is undertaken, expert assistance should be obtained to make sure that it can be carried through to completion successfully.

This paper was presented at NGAA annual convention, Houston, 1960.

Construction requirements. In working with LPG we are dealing with a material that is much less viscous than water and exerts a vapor pressure at ambient ground temperatures of 30-125 psi. It will go where water wouldn't think of going, and is hard to contain under any circumstances. The rock in which LPG is to be stored must be impervious, massive enough to allow the excavation of a cavity, and structurally sound. The rock must also be inert so that it will not react with the stored material.

Extremely sensitive and reliable methods of testing formations through pressure tests at core holes have been developed. Proper interpretation of these tests, along with laboratory tests and visual examination of the cores, result in a reasonable evaluation of the suitability of the rock for storage.

Fracturing data obtained from oilfield practices indicate that, generally, a pressure in excess of 1 lb. per ft. of depth is required to fracture a for-

mation. Stated in another way, the pressure exerted in the cavern would have to exceed the weight of the overburden before fracturing. Therefore, by industry agreement, a minimum depth of 1 ft. per lb. of anticipated operating pressure was established as the industry standard. As a general rule, caverns operate at less than 150 psi., but a minimum depth of 200 ft. has generally been adhered to.

Since perfect rock formations are seldom found, and pressure grouting to make a satisfactory seal in rock fractures is both difficult and expensive, it is common practice to locate caverns at a sufficient depth below the existing water table to cause a hydrostatic pressure at the cavern level that will be greater than the pressure of the product stored. Thus, any leakage would be into rather than out of the cavern.

If the principal geological requirements in Fig. 2 can be met, underground storage can be constructed.

In the United States, certain general geological characteristics are known, and broad areas have been tentatively classified as favorable or unfavorable for the mining of LPG storage caverns as shown in Fig. 1. However, these are generalizations and actual field testing is required before an accurate determination can be made on a speccific site.

Construction cost. A primary interest in the consideration of underground storage is cost. This is dependent upon labor rates, the plant facilities available, the size of the cavern, the geologic conditions encountered, and many other factors.

By plant facilities is meant terminal installations, dehydrators, fractionators, loading racks, land, etc. Most of these items will vary from place to place. However, considering the cavern alone, exclusive of land and plant facilities, costs can be approximated for general talking purposes.

Certain of the costs involved in constructing underground storage are independent of the capacity of the storage unit. There is the cost of geologic evaluation and testing, of sinking and lining the shaft, of drilling and equipping product handling wells, and of installing pipes, valves, meters, and other miscellaneous items that go with a cavern. In the average case, these total up to approximately $350,000.

The actual excavation cost is a variable which is largely dependent upon the labor cost in the area. For illustrative purposes in this case, we have assumed that the excavation could be handled for a cost of $3.00 per barrel of capacity. When these fixed and variable costs are combined, the cost of a mined cavern and the immediately related equipment, will vary from a cost of $6.50 for a 100,000-bbl. cavern to $3.88 for a 400,000-bbl. cavern. A breakdown of these costs is shown in Table 1.

TABLE 1—TYPICAL COST OF MINED STORAGE CAVERNS

FIXED COST

Geological studies, and testing	$ 25,000
Mine shaft, including sealing	100,000
Auxiliary drilled holes, piping, etc.	100,000
Pumps, valves, gages, and similar equipment	75,000
Mine development	50,000
Subtotal	$350,000

VARIABLE COST

$3.00 per barrel of capacity

TOTAL COST TO CONSTRUCT CAVERN

Capacity	Total cost	Cost per barrel
100,000	$ 650,000	$6.50
200,000	950,000	4.75
300,000	1,250,000	4.17
400,000	1,550,000	3.88

These costs are approximate, or for average cases. Actual costs have varied from just under $3.00 per barrel to just over $7.00 per barrel, depending on the sizes and conditions mentioned before.

Construction time. Another important consideration is how much time will be required to progress from the talking stage of a cavern to the use of the storage itself. Assuming that things move smoothly, and that there will be little delay between steps, the schedule shown in Table 2 represents a typical time table for a mined cavern of 200,000-bbl. capacity.

These time requirements are general figures and subject to considerable variations; however, experience has shown them to be realistic.

Fill and removal. After construction the caverns are filled by conventional methods, either with the product being dumped into the cavern at the top of the shaft and allowed to fall free down the shaft, or the fill line is extended to the cavern proper and the product distributed through a spray bar header or similar arrangement.

For removing the stored product, either submersible or deep welltype centrifugal pumps have generally been used. However, there are five installations that use compressors to provide a pressure differential for withdrawals.

Product loss. Operating losses, in general, are negligible. The usual practice is to remove only the liquid from the caverns which, of course, results in a perpetual inventory of vapor. There will be a waste during the first filling operation of something less than ½ of 1% of the capacity in the purging of the cavern and placing it in operation. After this first waste and inventory, the cavern should be normally filled and emptied with an operating loss of less than ½ of 1%.

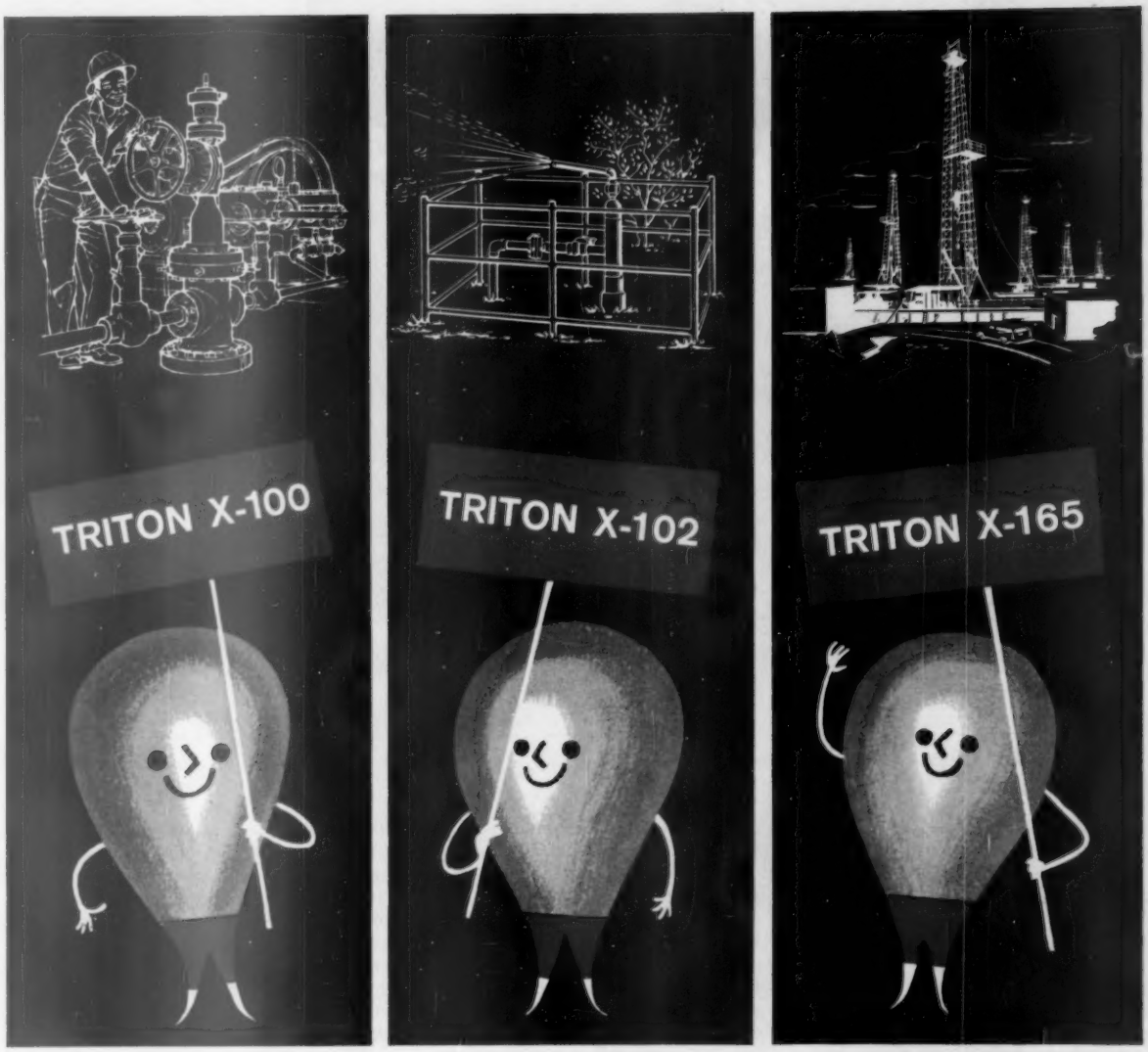
Another way of describing the operating losses that might be anticipated from a mined underground storage cavern would be to compare it to a similar terminal using aboveground steel storage. If all other operations were comparable and equal, you should expect the same operating losses from both terminals.

The principal users of mined underground storage in the LPG industry and the conditions under which they have found these facilities to be desirable are as follows:

1. LPG producing plants. The stor-

TABLE 2—TYPICAL TIME TABLE 200,000 BBL. CAVERN

ITEM	Time required in months	Cumulative time from start in months
1. Preliminary studies	1	1
2. Site selection and land option	2	3
3. Site investigation including core drilling, establishing basic design for the particular site, and probable cost	3	6
4. Detailed design	1	7
5. Construction of mine shaft	4	11
6. Mining	7	18
7. Testing and placing in operation	1	19



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Want to raise injectivity indices in water-flooding? Remove water from drowned gas wells? Foam-off intruding water while air drilling?

For each of these jobs, there's a TRITON surfactant that's proved its value and economy in actual use. TRITON X-100 for cleaning out injection wells . . . TRITON X-102 for foaming out water, light and heavy brine and particles from drowned gas wells . . . and TRITON X-165 for foaming out water and drill cuttings during air drilling.

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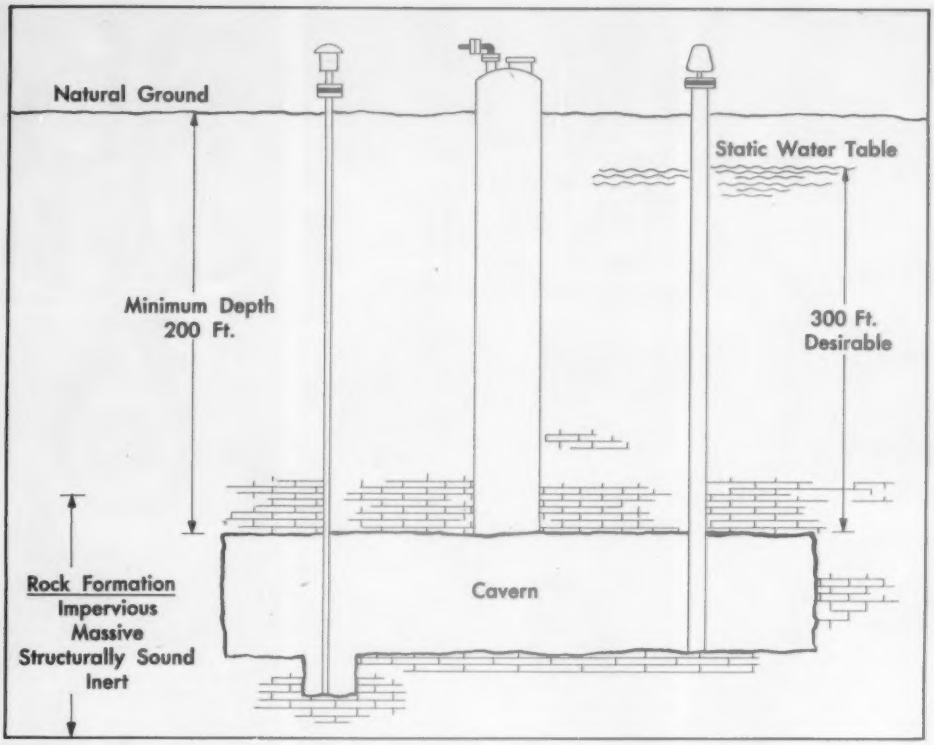


BASIC REQUIREMENTS must be met to successfully complete mined underground storage caverns for LPG. Fig. 1.

age at these locations is used to smooth out the peaks and valleys of demand against a more or less constant production, and also to aid in economical scheduling of transportation facilities. Many companies have found that a volume sufficient to cover somewhere between 30 and 60 days' production can satisfactorily smooth out their entire year's operation.

2. Distribution terminals. Recently, there has developed an increased interest in terminals in the sales or consuming areas large enough to give the customers assurance of product always being available, and also large enough to provide the company with flexibility and better use of their shipping facilities. Many of these terminals, in addition to serving a local market, also provide intransit storage for their company's operations.

3. Refineries. Many refineries have found it profitable to have underground butane storage in an amount roughly equal to three times their daily crude oil capacity.

4. Pipeline terminals. To have successful pipeline movement of LPG, it is necessary to have large-volume storage at both the delivering and receiving ends of the line; therefore, many of these pipelines use one, and sometimes several, mined storage caverns.

5. Barge and ship transportation. There has been little activity in this field to date, but barge and ship transportation will probably be the cause for several new installations over the next few years.

6. Petrochemical industry. Some petrochemical plants are finding that mined storage is a logical method of storing feed stock at their plant location to insure availability of product and to reduce the effect of transportation difficulties.

7. Gas utilities. For years propane-air plants have been used for handling peak demands. Formerly these plants could be justified economically only on small installations. Over half of the investment in a gas-air plant was in aboveground steel tank storage which cost about $20 to $30 per barrel of capacity. Now mined underground storage at a cost of $4 or $5 per barrel can be used at many locations.

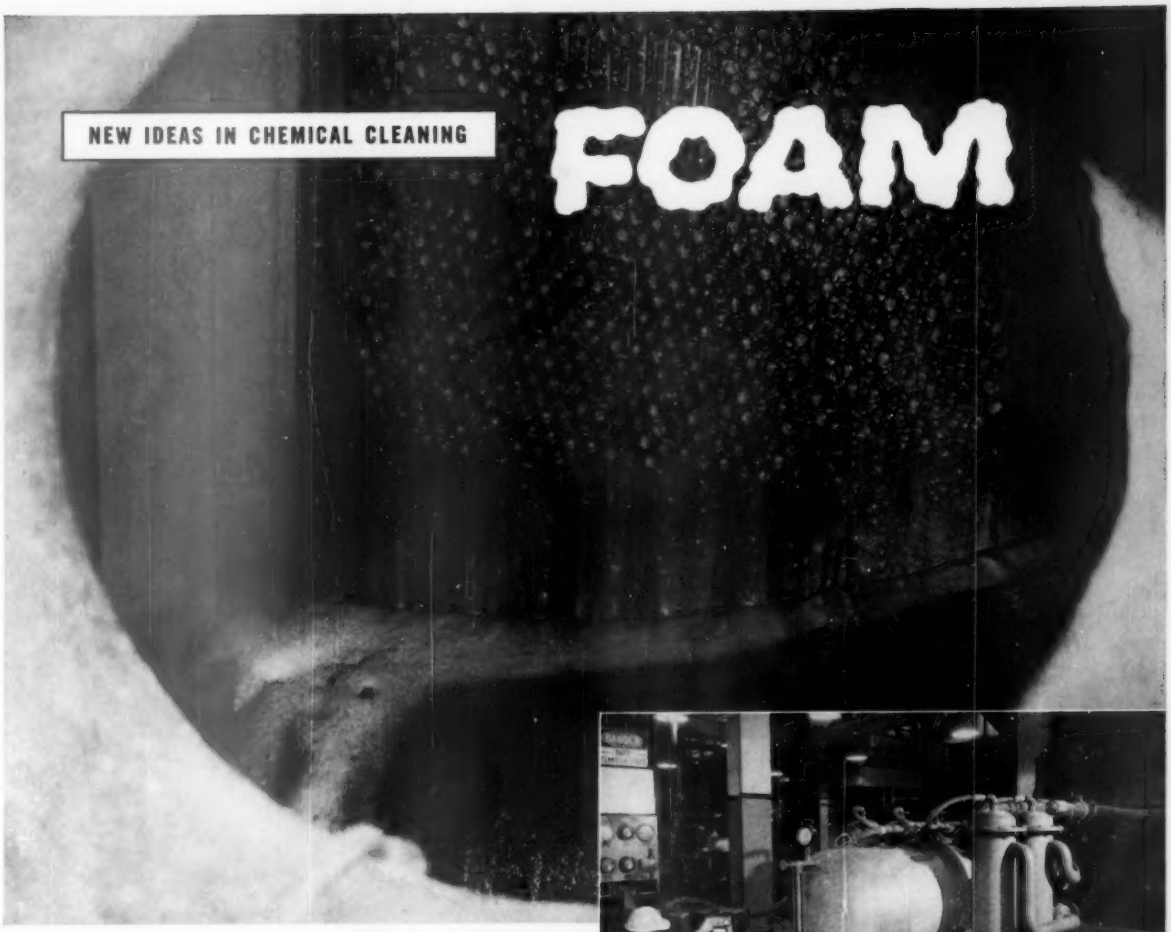
On a cost per barrel basis, underground storage in mined caverns is relatively inexpensive and unit cost decreases with volume. The term "inexpensive" is used advisedly, because—though the cost per barrel may reduce with increased capacity—the total cost increases, and a large initial investment will be involved in any underground storage project. A company should also be prepared to take care of contingencies where an expenditure of as much as $50,000-$100,000 might be involved in order to make the cavern useful. The contingencies requiring this expenditure are all normal to underground construction and mining, and are primarily factors involving unknown reactions and stresses of rock underground, indeterminable quantities of ground water, and the possibility of encountering freak geological deviations.

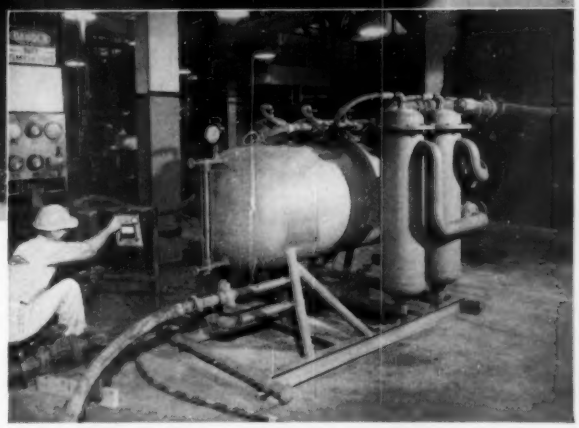
When all of these items are considered, the question naturally arises as to what risk is involved in undertaking the construction of a mined storage cavern. In this instance, history speaks for itself. During the past 7 years all cavern projects started have been successfully completed. Every cavern constructed to date on sound engineering studies and competent construction practices has been successful.

Time, know how, and a substantial investment are required to develop an underground storage cavern. It is recommended that those contemplating the construction of an underground unit use experienced technical help; and that a thorough physical testing program be made before starting any major capital outlay. These steps, though they can't combat all of nature's idiosyncrasies, will at least minimize the risks involved, and aid in the successful completion of a mined LPG storage unit.

NEW IDEAS IN CHEMICAL CLEANING

FOAM





Above: This view through a condenser inspection port shows foamed acid in action. Right: A foam generator being used to clean a large condenser.

Dow Industrial Service Uses Foam For Better Cleaning, Lower Cost

A newly-developed method of chemical cleaning is helping plant operators reduce the cost of cleaning large-volume vessels.

The new method uses a foaming agent and a special foam generator to expand inhibited acids, water or alkaline solutions to many times their liquid volumes. Foam-to-liquid ratios up to 300-to-one can be attained. For most applications, however, acid is expanded 20 times.

Chemical costs of cleaning large volume vessels with foam instead of liquid are reduced because far less solvent is required.

Reduced solvent requirements mean that disposal or neutralization is simplified.

The light weight of foam makes possible the chemical cleaning of structures where weight is critical.

Foam cleans faster than liquids because solvents can be used at higher concentrations. This helps to reduce both cleaning and outage time.

Certain mechanical benefits result from the use of foamed solvents. The foam provides a scouring action not given by liquids and it carries sloughed materials readily.

Also, foamed solvent fills vessels, pipes and even bent piping as a plug. This eliminates the need for vent connections and reduces the hazard of gases because they are swept out as they are formed.

The foam cleaning technique is just one of many recent developments by Dow Industrial Service to make chemical cleaning faster, safer and less costly.

For engineered recommendations to solve your cleaning problems, contact the field office nearest you, or write Dow Industrial Service, 20575 Center Ridge Road, Cleveland 16, Ohio.

Chemical Cleaning Services for all industry

DOW INDUSTRIAL SERVICE

DIVISION OF THE DOW CHEMICAL COMPANY

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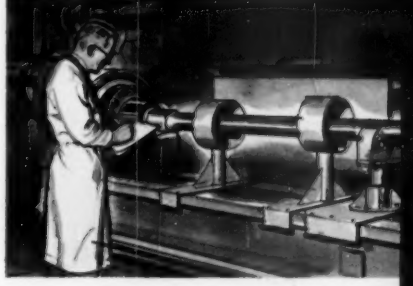
Reed research, engineering, and experience are your assurance of the very best in tool joints today *and* tomorrow.

When you buy your next string, remember this—Reed Tool Joints will outlast any others!



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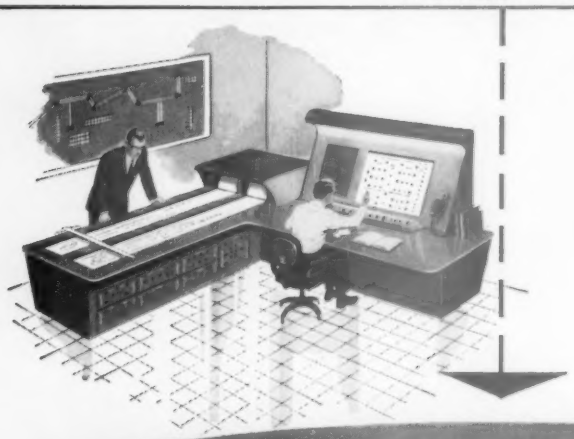
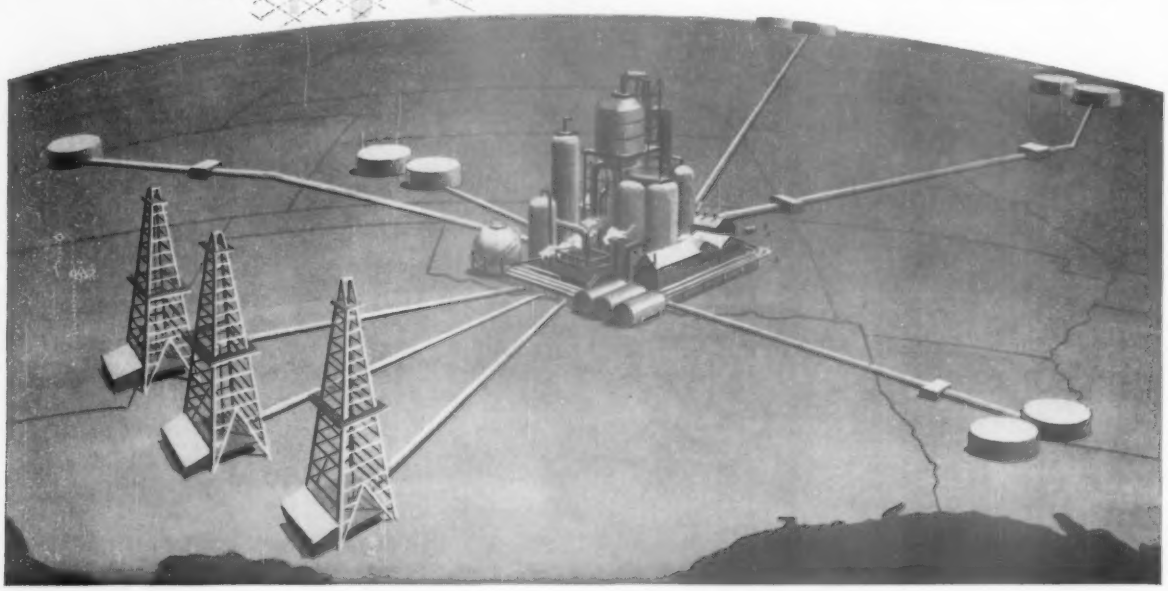


SIMULATING PRODUCTS PIPELINES WITH LINK Dialog*



Optimum pipe line operation requires fast and accurate analyses of the many variables involved to assure economic delivery of pipe line products.

A Link Pipe Line Simulator is an indispensable tool for **profit-minded** pipe line management. It incorporates high-speed digital/analog computing techniques to—

- analyze economic capability of pipe line
- predict and program varying product demands
- compare operating alternatives
- study operational techniques

With the Pipe Line Simulator, you can be assured of reducing operating costs because it provides—

- precise scheduling of multiple product requirements
- reliable and dependable dispatching
- rapid re-scheduling to meet 'up-sets' or emergencies
- engineering data for design and systems study

The Dialog* Pipe Line Simulator is just one of the many Link engineered systems for serving the control, scheduling and analysis demands of the petroleum, gas, and petro-chemical industries.

For specific details on Link Dialog Pipe Line Simulators, write to J. C. Croft, Jr., Manager, Industrial Control Products, Link Division, General Precision Inc., Binghamton, N. Y

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LINK DIVISION
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another example of Link / ability

GENERAL PRECISION, INC.

HYDRAULIC POWER SLIPS suspend each of five strings independently at the table. Power tongs were used to make up new joints. Five hydraulic testing units pressured each joint to 6,000 psi. as it was run.

Running strings simultaneously makes

first quintuple completion fast and certain

Five strings (30,500 ft. of tubing) above top packer took only 42 hours

FIVE WELLS now produce from a single hole in Block 190 field, 40 miles offshore from Eugene Island, Louisiana. And in completing this hole, the operator, Sinclair Oil & Gas Co., has accomplished something beyond merely adding one more of everything to the quadruples it and other companies had already made.

The quintuple is oil-producing evidence that multiple-string completions can be made with speed and certainty. It shows that the days are gone when long hours must be spent in strapping together any tubing strings run simultaneously. It proves the gamble is gone that once attended the ticklish process of running the multiple strings

BY ED McGHEE
Drilling Editor

one by one; when this was done, it was an extremely delicate matter to get each string stabbed into its packer far downhole.

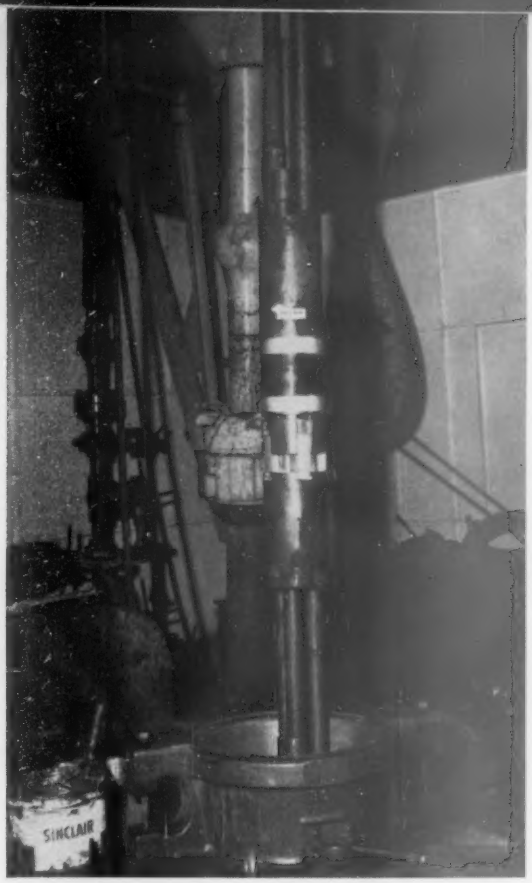
It took only 56 hours' rig time to run all packers and 33,100 ft. of tubing into Sinclair's OCSO439 No. 6. This speed is a result of the use of multiple slips and elevators which handle all strings simultaneously without strapping. Moreover, all the downhole equipment went into the well in its logical sequence, in the order of its final working place in the well.

Running the five strings (30,500 ft. of tubing) above the top packer required only 42 hours.

Then the christmas tree was installed, mud circulated out, and the packers set in quick and orderly fashion.

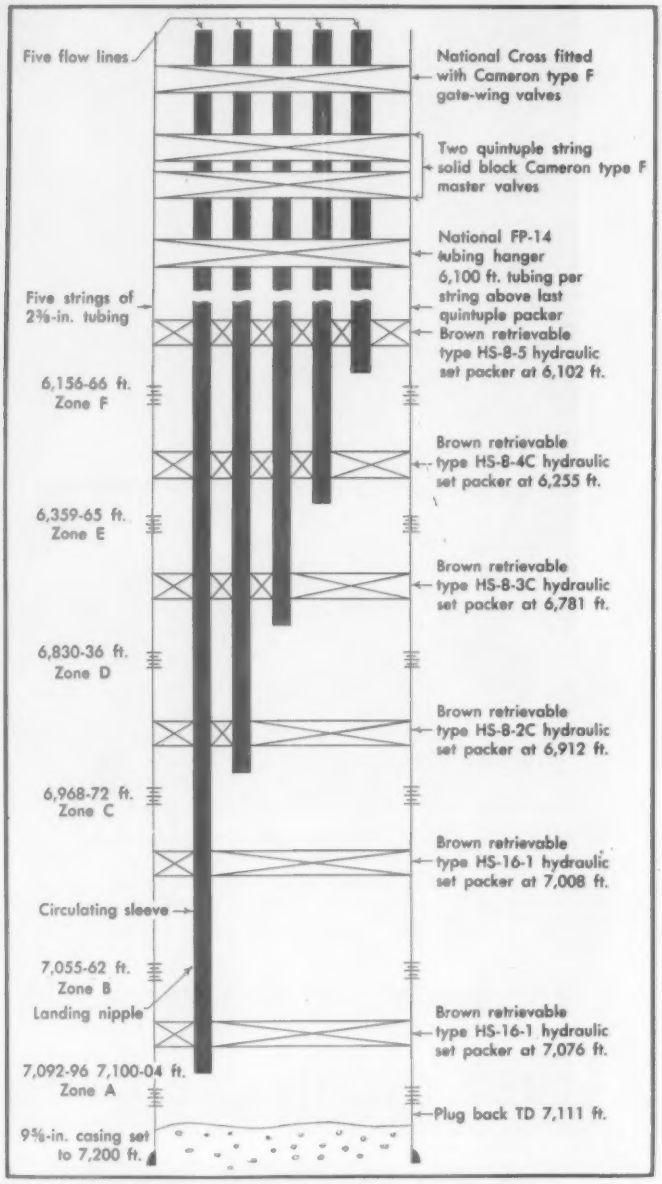
Quick payout, all too infrequent offshore, is the normal result of such efficient equipment and operation.

Four-company operation. Sinclair, though operator for the new quintuple, is not sole owner; El Paso Natural Gas Co., Peoples Production Co., and Sohio Petroleum Co. are equal partners in the venture. Previously the four-company combine had com-



WORLD'S FIRST FIVE-STRING PACKER as it goes through rotary into well. This is only one of the six packers which did not have holddown bottoms; pressure of fluid in annulus will prevent it from moving whether zone below is producing or shut in.

FIVE-STRING blowout preventer, stripper type, is set into place by Jack Downing and Robert Roberts, Brown Oil Tools. Inside each of five stripper units are metal slips which prevent tubing from blowing out of the hole if there's pressure on the wellhead.

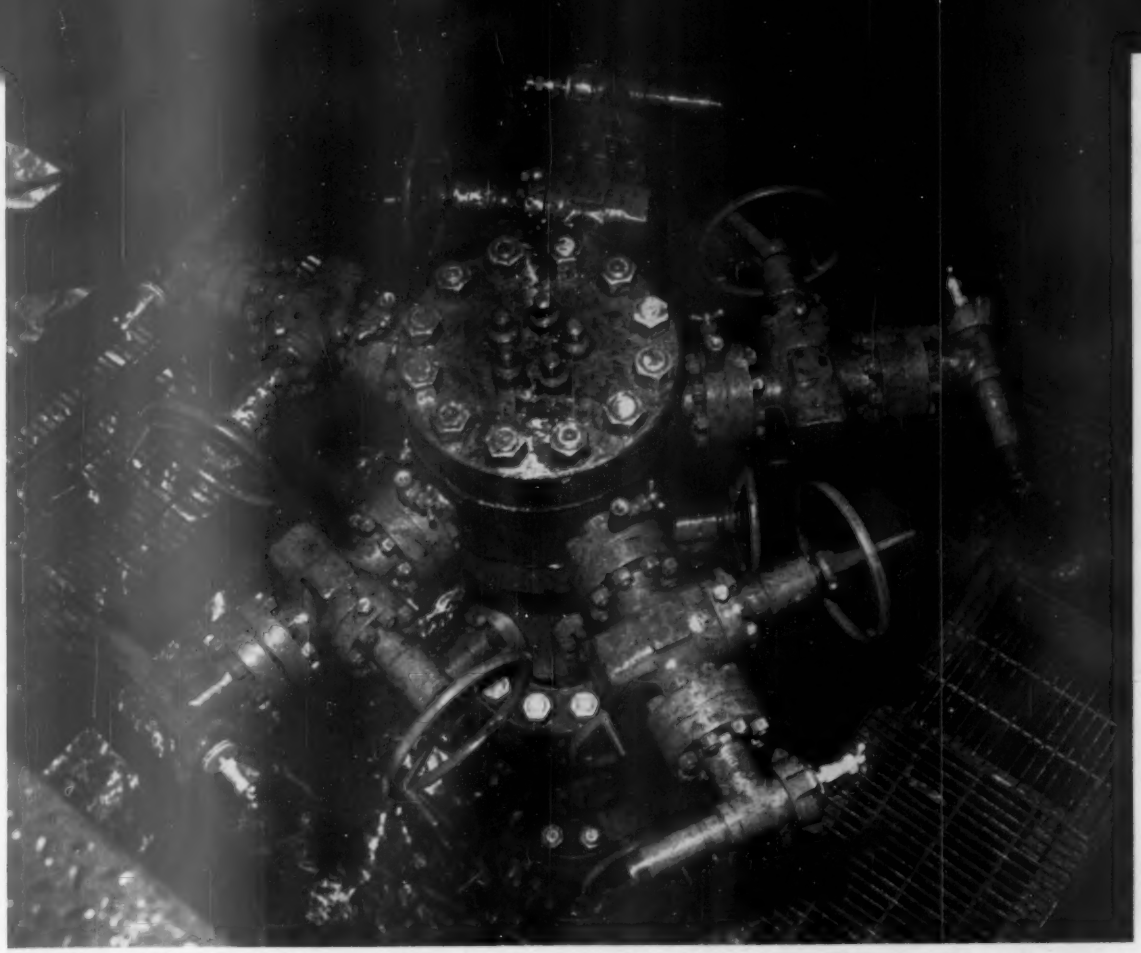

Five flow lines
National Cross fitted with Cameron type F gate-wing valves
Two quintuple string solid block Cameron type F master valves
National FP-14 tubing hanger
6,100 ft. tubing per string above last quintuple packer
Five strings of 2⅜-in. tubing
Brown retrievable type HS-8-5 hydraulic set packer at 6,102 ft.
6,156-66 ft. Zone F
Brown retrievable type HS-8-4C hydraulic set packer at 6,255 ft.
6,359-65 ft. Zone E
Brown retrievable type HS-8-3C hydraulic set packer at 6,781 ft.
6,830-36 ft. Zone D
Brown retrievable type HS-8-2C hydraulic set packer at 6,912 ft.
6,968-72 ft. Zone C
Brown retrievable type HS-16-1 hydraulic set packer at 7,008 ft.
Circulating sleeve
7,055-62 ft. Zone B
Landing nipple
Brown retrievable type HS-16-1 hydraulic set packer at 7,076 ft.
7,092-96 7,100-04 ft. Zone A
Plug back TD 7,111 ft.
9⅝-in. casing set to 7,200 ft.

SIX OPEN ZONES feature world's first quintuple completion. Bottom two can be produced alternately. With the exception of the quintuple packer, all the equipment had previously been proved in dual, triple, and quadruple completions.

pleted in the same area a single-zone oil well and one of the industry's early four-zone gas wells.

Contractor on the well was Dixilyn Drilling Corp. working from its three-legged mobile platform, the "Julie Ann." Water depth at the site is 72 ft.

Unlike many offshore wells, No. 6 is not a directional hole but, rather, is vertical. It is cased with 9⅝-in. pipe to 7,200 ft. and plugged back to 7,111 ft. Seven promising sands were tested in the well; only one (from 6,302 to 6,308 ft.) was not good enough to produce. Thus, on February 29, 1960, when the first packer



WELLHEAD EQUIPMENT included 5 wing valves and 10 master valves. Master valves and flow tee are made from single pieces of steel. Over-all height of tree is more than 10 ft., hardly more than many high-pressure single wells.

was run into the hole for completion, six separate sands had been perforated and were open.

Size of the casing precluded any thought of making a six-string completion, but it looked practical to attempt a five-string completion with the sixth zone being packed off and held as an alternate source of production for the longest string. If this were done, a total of six packers would be needed: two single packers above each of the lowest two sands which would be alternates for the long string; a dual packer above the third-from-bottom sand; a triple above the next; and a quadruple and quintuple packer above the last two sands in sequence.

This six-packer plan was followed. Picked for the job were six Brown Oil Tool hydraulic-set models. These packers can be run in on the tubing and set by pump pressure from the surface after the wellhead is in place. Also, these packers contain holddown buttons which are actuated by pressure below the packer and prevent movement in case pressure above the packer is less than that below.

Running the tubing. All tubing to be used below the top packer was tallied and spacing worked out on paper before actual work started. As a result, no time was lost in picking and choosing joints to fit.

The first two packers (single models) were run in with tubing connecting them in normal fashion; enough additional tubing was run in after the second packer to space out to the third (dual) packer.

At this point, the multiple slips and elevators came into use. Until all packers were in, the slip bowl used segmented sections which could be removed to pass the packers through the table.

After all packers were in, the removable slip segments were exchanged for a one-piece multiple slips. These one-piece multiple-string slips are almost identical to the elements used to suspend the multiple strings in the elevators. Both elevators in the derrick and slip bowl on the floor were hydraulically powered and controlled by the driller. These and power-operated tubing tongs for making up new joints speeded up running-in operations.

As each packer was run into the well, another tubing string was added side by side. To this point, all the tubing was 2⅜-in. o.d. CS Hydril with minor exceptions: one string between the quin and quad packers was 2⅞-in. o.d. CS Hydril; another was 1½-in. o.d. in the same distance.

When the sixth and final packer went through the table, some 2,600 ft. of tubing, packers, and other equipment had been run. Total elapsed time was only 13½ hours.

From this point on, 6,100 ft. of pipe had to be added to each of the five strings. All tubing above the packers was 2⅜-in. o.d. Spang XLine except for a portion of one string which was regular 2⅜-in. eight-round tubing.

As the tubing was run, a new stripper-type preventer guarded against the well coming in prematurely. This Brown stripper has five individual openings through which the tubing strings run. Metal slip segments inside the stripper keep the tubing from blowing out of the hole if string weight isn't sufficient.

Tubing safety valves were kept handy on the rig floor to be stabbed into each string should the well begin coming in through the tubing.

As the tubing was run, each joint was hydrostatically tested to 6,000 psi. to make sure there'd be no leaks after the well was on production. Since all tubing had been internally plastic-coated, the hydrostatic test tools used dual-seat assemblies with no metal

FIVE NEW JOINTS are stabbed into quintuple tubing strings. Elevators are slip type which not only suspend each string independently, but are also hydraulic-power operated by the driller.

parts to cause damage to the coating.

Testing was speeded by using two separate test units.

Other tubing equipment. The six packers weren't the only equipment run into the well on the tubing strings. First of all, there was a landing nipple and a circulating sleeve immediately above the bottom packer. Together, this equipment acts like a three-way valve which alternately opens one and then the other zone to produce through the long string. The landing nipple seats a plug which can be run or pulled to shut off or open up the bottom zone; the circulating sleeve can be opened or closed to control the second zone.

Other circulating sleeves are located in other tubing strings between higher packers; these make it possible to circulate down one string and back up another without unseating any packers. The sleeves are located so that mud or any other fluid can be circulated down to any producing sand.

There are also other landing nipples in the strings, both between packers and above them. Into these nipples can be seated a large number of wireline tools for many different well-service jobs.

In addition, there are "abrasion joints" on any string where it lies in front of a set of producing perforations. That is, there are five such abrasion joints on the long string, three on the next-longest, two on the next, and one on the next. These rubber-sleeved joints resist sand cutting that sometimes results from gas and sand blasting through only a few perforations. Without the sleeving, holes might be cut in the tubing and make a workover necessary.

Adjustable unions were put into the strings just below each packer. As these unions have a 14-in. stroke, it was an easy matter to secure the packer to all strings without having to cut and fit nipples.

Also just below each packer, there is a safety joint in each string. Some of these are the "crisscross" type; others, the shear-pin type. Purpose of both is the same: they can be parted intentionally by manipulating the tubing at the surface. Thus, the packers and tubing can be systematically pulled out of the well in case a workover of all zones is necessary.

On the end of each tubing string, there is a reduced-diameter shoulder. Its purpose is to catch and seal against a plastic ball pumped down the tubing string. When the ball is in place against the shoulder, the tubing string is pressuretight—a necessary condition to setting the hydraulic packers.

Seating the packers. The last joint in each tubing string was picked so that all strings came out the same length. Then, the tubing was ready to be hung. Hanger is a National Type FP-14; it consists of a mother hanger with five openings and an individual hanger for each string.

The mother hanger was placed on the five strings with its slot opening faced in the proper direction for landing. As the tubing strings had been run, they were kept facing in their proper direction by first orienting the No. 1 string and then locking the hook.

The individual-string hangers were placed on each string and the group landed in the mother hanger. This entire hanger assembly was then landed as a unit by letting it down with five joints of tubing added one above each hanger. The index pin was screwed in, thus orienting the tubing head and hanger properly for the christmas tree to be put on.

The tree contains two Cameron five-string solid-block master valves, one above the other, and a National five-port flow tee. Each tubing wing carries a wing valve and choke box. Thus, each zone has two master valves and one wing valve; all are Type F Cameron gate valves.

After the tree was in place, the well was under complete control at the surface so that mud could be safely displaced out of the hole. The 11.7-lb. per gal. mud used until this time was reversed out of the well by pumping down the annulus and up the No. 5 (shortest) string. The mud was displaced out by a 11.2-lb. per gal. solution of calcium chloride; this no-solids "packer fluid" guarantees against trouble from gelling or settling of mud particles as the well continues producing through the years.

When the annulus and the No. 5 string were free of mud, a plastic ball was pumped down the string and the quintuple packer set by pressuring up to 5,000 psi. Topside seal of the packer was tested by pressuring the casing to 1,800 psi. and bleeding off the No. 5 string; pressure remained steady in the annulus, showing the packer was holding.

Next, the calcium chloride solution was pumped down the No. 4 string, displacing the mud there back up the No. 5 string. At the same time, this circulated the setting ball out of the No. 5 string.

Then the quintuple packer was tested from below. Pressure in the casing was bled down to 600 psi. while 2,000 psi. was put below the packer. It held.

The quadruple packer was set and tested in a similar manner. It set and held satisfactorily. So did the triple and dual packers.

Both single packers were set simultaneously by pressurizing against a ball resting on the end of the long string. Since this ball could not be retrieved by reversing out, the shoulder had been made to shear off and fall to the bottom of the hole after the packers were set.

Swabbed into production. After the packers were set, each zone was swabbed into production individually. It was during this process that the only real trouble arose and this trouble was caused in no way by any of the quintuple-completion equipment. A swab line parted and dropped into one of the strings.

A line and swab could not be retrieved by usual fishing means. As a result, Sinclair decided to back off the affected string above the top packer and pull it out of the hole. This was done although many thought it would never be possible to rerun the string and stab it back into place. And, it was done with the other four strings still hanging out of the wellhead.

The string was pulled and the swab line recovered. Then the string was rerun and successfully stabbed back into the remainder of the tubing in the hole. The process, though hazardous, was done without unexpected difficulty and the string was put on production almost immediately afterward.

Sinclair's No. 6 OSCO439 is currently shut in. There's no pipeline to the well yet and there's no storage for all the oil the five-in-one well can produce. However, all five zones have been tested productive and will flow when the needed production equipment is installed.

PIPELINE REPORT A special section of THE OIL AND GAS JOURNAL

How Tapline went about

Predicting and controlling transient pressures in long pipelines

BY RICHARD R. BURNETT

. . . assistant chief engineer, Trans-Arabian Pipe Line Co., Beirut, Lebanon, joined Tapline in 1949 as a mechanical engineer and was named to his present position in May 1958. He was graduated from University of California in 1949 with a BS in electrical engineering and received an MS in mechanical engineering from Columbia University in 1954.

PRESSURE SURGES generated in Trans-Arabian Pipe Line Co.'s large-diameter pipeline, by tripping off 5,000-hp. gas-turbine pumping units, require careful analysis to avoid overstressing the pipe.

This article describes the methods used to predict and control high-pressure traveling waves on the line.

The addition of 5,000-hp. intermediate gas-turbine pumping units to the 754-mile crude line was completed near the end of 1957.[1] One of these units was installed about midway in each of the four original pipeline sections. Each unit is designed for remote operation by VHF radio link from the next upstream pump station and is automatically tripped off should any one of several unsafe conditions actuate a protective shutdown device.[2]

Referring to the map (Fig. 1), Tapline's original system consisted of the 30-31-in. pipeline, four pump stations in Saudi Arabia, and the marine terminal near Sidon, Lebanon. Each pump station was provided with a 96,000-bbl. floating-roof tank which is open to the pump station incoming stream and prevents the generation of high-pressure surges if a station is unexpectedly shut down. Thus, in a hydraulic sense, each of the four sections is a separate pipeline.

An intermediate gas-turbine-driven pump was installed without a tank, at approximately the midpoint of each of the four sections. Whenever one of these units is tripped off by a safety device, the pump suction pressure

Presented at Annual Pipeline Conference, API Division of Transportation, Tulsa, April 28-29, 1960, under title, "Transient Pressures in Long Pipelines."

The author says . . .

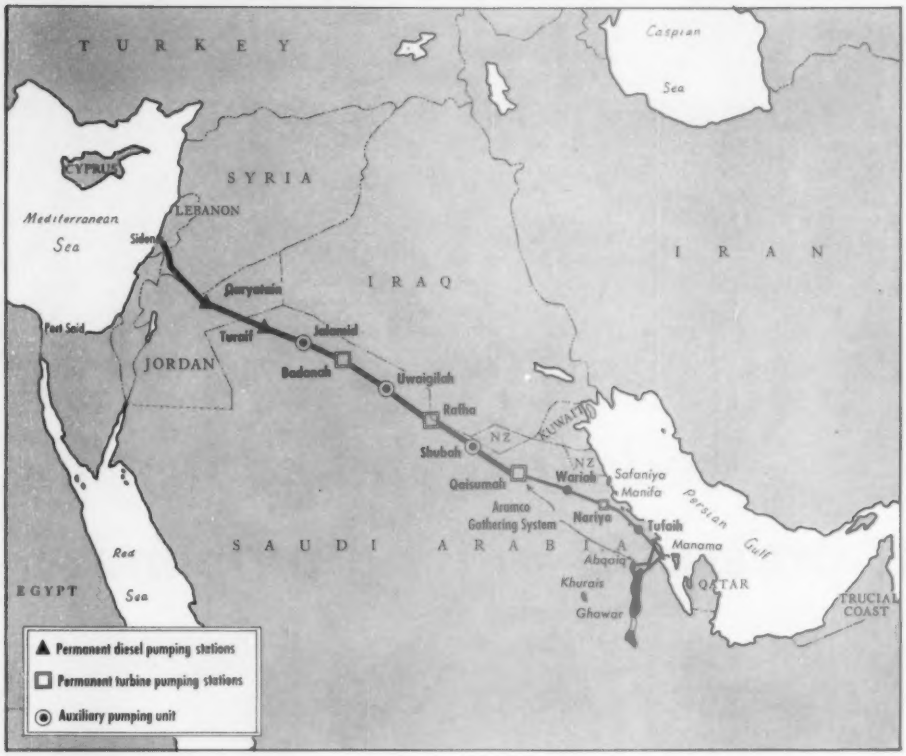
1. Control of surge pressure by automatically reducing upstream pressure proved to be generally satisfactory in the application described. This method requires detailed analysis of surge pressures. Also it is feasible only if a dependable communications system is installed.

2. The analytical solution for wave-front attenuation has been used successfully. However, comparison with data and with the numerical solution indicates that the assumed linear pressure-velocity relation in the wave front is only approximately correct and its error becomes more significant for slower rates of pressure change.

3. The numerical solution, developed mainly for pressure-velocity-time relations at a fixed location, offers a means for solving a wide range of transient-flow problems with a reasonable amount of effort.

4. In designing a new pipeline system, significant economy can be gained in many cases by advance analysis of transient-pressure distribution.

5. The analysis of pressure-velocity-time relations may be useful in predicting the transient performance of control valves and pumps and the response of pump-station-control systems.



INTERMEDIATE stations installed without tankage created pressure-surge problem on Trans-Arabian Pipe Line System. Fig. 1.

rises rapidly and initiates a high-pressure surge which travels upstream to the next pump station.

The pipeline has a tapered wall thickness—that is, the thicker pipe wall is installed on the discharge side of the pump stations, where the normal pressures are high, while the thinner wall is in regions of normally low pressure such as those immediately upstream from the gas-turbine units. These latter regions are subjected to the highest surge pressure.

At points where the wall thickness changes, the situation is usually the most critical because the initial gradient pressure is relatively high in relation to the maximum allowable pressure, leaving less available to take the surge. In several cases, these points would be overstressed unless measures were taken to control the surge pressures.

The simplest control method would be to lower the normal operating pressures to allow for surges. But this method would reduce the pipeline throughput, and it was calculated that approximately 40,000 bbl. daily of throughput would be lost unless other effective surge-protective systems could be devised.

Design Features

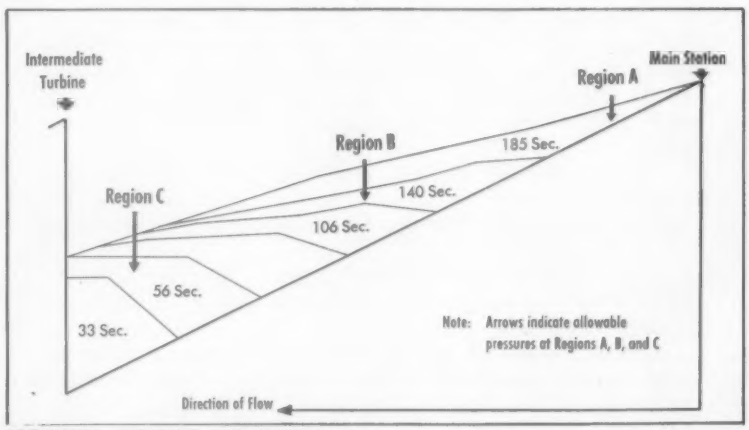
With this incentive, a detailed study of available transient-pressure theory was made. The definitive work on the subject is by Ludwig and Johnson,[3] who developed the theory for sudden change of flow, and attenuation of the resulting traveling pressure wave in a long pipeline. It was assumed that, when a pumping unit tripped off, its suction pressure would rise suddenly until either of two things happened:

1. With a relatively small initial differential pressure across the pump, the rise in suction pressure would be arrested when it equalized with the falling discharge pressure and flow would then be resumed through the check valve which bypasses the pump, or

2. With higher differential pressure, the suction pressure would rise until flow stopped, after which a more gradual rise would continue until equalization of suction and discharge pressures occurred.

In either case, a pressure surge would travel upstream at acoustic velocity, diminishing its magnitude as it progressed. Each pumping unit was provided with a check valve in series with the pump, so the possibility of flow reversal was discarded. The analysis, an example of which is shown in Fig. 2, assured that:

1. The pressure equalized at the intermediate turbine unit approximately midway between the initial



PREDICTED PRESSURE DISTRIBUTION for uncontrolled surges when turbine unit trips off. Fig. 2.

suction and discharge pressures, and

2. The maximum pressures reached along the line could be approximated by drawing a straight line from the midway pressure at the intermediate unit to a point somewhat above the initial upstream station pressure. This line was approximated by using Ludwig's curves for pressure distribution in the wake of the traveling wave front and modifying them to take into account the flow through intermediate turbine location.

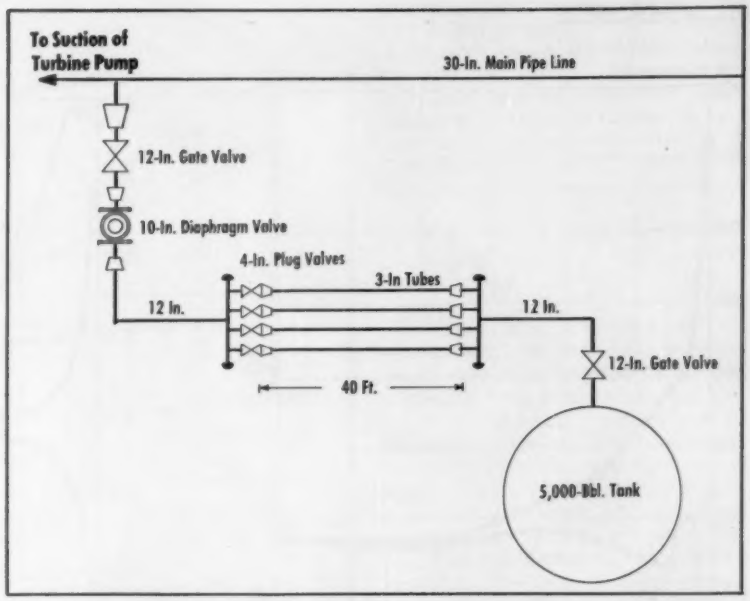
Subsequent tests revealed that pressure equalized at a level significantly below midway at the turbine unit, but after making this correction, the straight line described above was a conservative first approximation to the actual pressure buildup in upstream regions.

These detailed calculations were made with the thought that protection against overpressuring the critical areas might be achieved by rapidly reducing the upstream pump station pressure, transmitting a rarefaction wave to intercept and subtract from the oncoming high-pressure surge. The analysis led to classifying the critical regions of the pipeline as shown in Fig. 2. The lines marked "33 seconds," "56 seconds," etc., show the predicted progress of an uncontrolled pressure surge after tripping off the unit. All three of the critical regions A, B, and C, would be overpressured. These representative regions were considered individually as follows:

Region A—This is the control point at which pipe-wall thickness changes and limits normal operating pressure. Since this is near the upstream station, it is evident that a rarefaction wave initiated by quickly reducing the station pressure would reach this region to protect it before the high-pressure surge would arrive from the gas-turbine unit.

Region B—This is a critical point of wall-thickness change, located somewhat nearer to the intermediate pumping unit than to the upstream station. In this example, 106 seconds would elapse before the pressure would exceed the allowed limit. It was decided, subject to final tests, that this region could also be protected by reducing upstream station pressure.

Regions of the A and B types occur in all four sections on Tapline, so systems were designed to accomplish rapid base-station pressure reduction whenever a gas-turbine unit trips off. This feature is provided by transmitting a continuous tone over the VHF communications system from the gas-turbine unit to the upstream station so long as the gas-turbine unit is in operation.



SURGE-PRESSURE RELIEF system is shown at Qaryatain. Fig. 3.

The tone is used to hold open a relay in three of the six diesel-engine shutdown circuits at Qaisumah, Rafha, Badanah and a shift in frequency of the tone shuts down the three units. At Turaif, which is powered by two 5,000-hp. gas-turbine pumping units, a frequency shift in the tone from Qaryatain reduces the two Turaif units to idle speed, thus decreasing Turaif's outbound pressure.

Region C—Excessively high pressures would build up here within approximately 35 to 40 seconds. A rarefaction wave from the upstream station would be unable to reach this region soon enough for protection. It was decided that a relief valve could be installed on the suction side of the pumping unit to limit the pressure rise. Fortunately, a region of this type exists only in the Turaif-Qaryatain section, so a relief valve was installed only at Qaryatain.

This relief system is shown in Fig. 3 and consists functionally of the relief valve, four 3-in. pressure-reducing tubes, and a 5,000-bbl. receiving tank. The relief valve is a 10-in. control valve arranged so that air pressure on the diaphragm operator opens the valve. An air-supply tank and controls are located near the valve and function in the following manner:

1. When the pumping unit trips off, the air-tank pressure is applied directly to the valve diaphragm operator for fast opening.

2. After the valve is opened, air to the diaphragm is controlled by a pressure controller set to hold 300 psi. on the main pipeline.

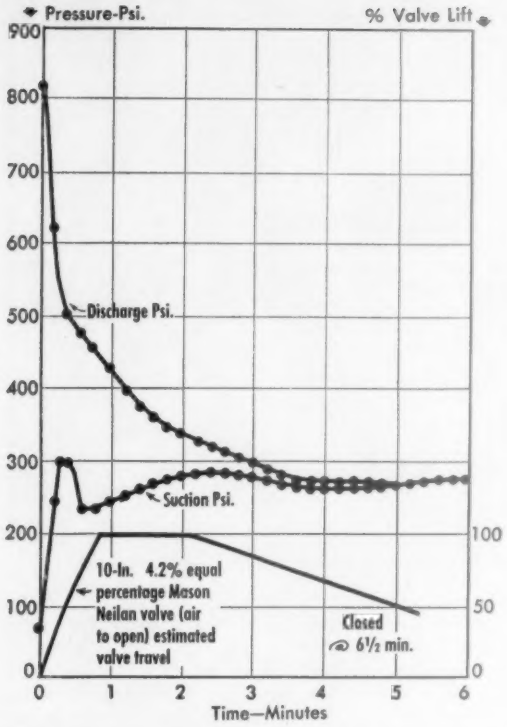
3. After a preset time interval, the air is bled off the diaphragm at a controlled rate until the valve is closed.

The entire cycle returns the valve to the closed position 6 to 7 minutes after the turbine unit is tripped off. This time allows for the effect of Turaif's pressure reduction to be transmitted through Qaryatain and for some degree of pressure stabilization to take place throughout the pipeline. In designing this system. it was hoped that the valve could be opened at nearly an optimum rate which would allow Qaryatain's suction pressure to rise smoothly to approximately 300 psi.

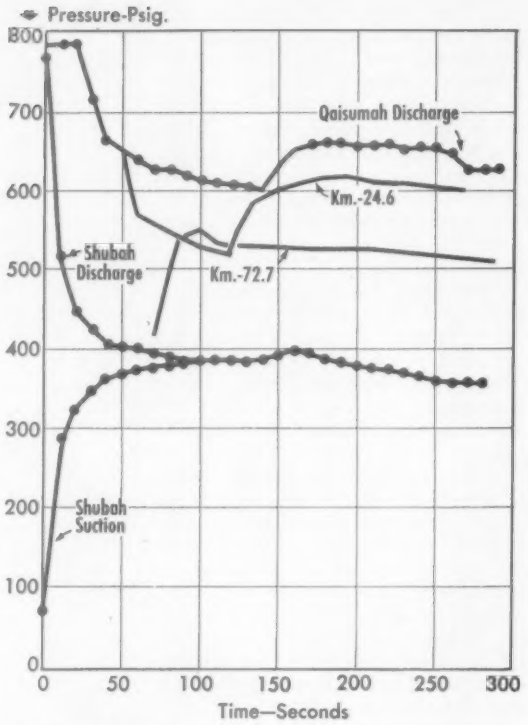
This was desirable since the rise in pressure is accompanied by a reduction of flow in the incoming stream. Allowing the pressure to rise to the maximum safe value (determined by the allowable surge at upstream Region C) effectively minimizes the volume of relief flow through this valve. Fig. 4 gives the test pressures and valve position versus time after tripping off the Qaryatain pumping unit.

Testing installed facilities. After completing the installations, extensive surge-pressure tests were required to check the feasibility of the designed surge-protection systems and to make final adjustments.

Testing techniques were simple and common to all the tests. Transient pressures versus time were obtained at each critical location by installing a tested laboratory-type bourdon-tube pressure gage. Readings were recorded by an observer at 10-second intervals.



PRESSURES AND RELIEF-VALVE position after tripping off turbine unit at Qaryatain. Fig. 4.



SURGE PRESSURES are shown after turbine unit has tripped off at the Shubah station. Fig. 5.

For each of the four pipeline sections, the test procedure which was used to determine the effectiveness of the upstream pressure reduction was as follows:

1. Three gas-turbine shutdowns were made with the upstream station pressure held constant so that the deterioration of the high-pressure wave front and pressure distribution in its wake could be clearly observed. Initial pumping-unit differential pressure was increased in each successive test with the hope that results could be extrapolated to maximum conditions.

2. At least one test of the effect of reducing base-station pressure was run, recording wave behavior as it traveled downstream. The gas-turbine unit was off stream for this test.

3. One or more tests were made, tripping off the gas-turbine unit and automatically reducing the upstream station pressure.

In Fig. 5, pressure readings for one of the composite test runs are shown. An unusual requirement of this particular test was to determine the magnitude of the pressure wave front at km. 72.7 after the Shubah gas-turbine unit was tripped off, under a condition of high differential pressure. If the automatic pressure-reduction system at Qaisumah were allowed to operate normally, the rarefaction wave would have met the oncoming wave from Shubah at approximately km. 70, so that measurement at km. 72.7 would be difficult to interpret.

On the other hand, the surge from Shubah, if not limited, would eventually overpressure the region of km. 72.7. Therefore, the procedure was to start with a somewhat lower initial pressure and to delay manually the Qaisumah pressure reduction for 20 seconds, which allowed the full wave front to pass through km. 72.7 before it was intercepted by the rarefaction wave. At normal pressures, the surge must be interrupted within 10 seconds after it reaches km. 72.7. Thus, Qaisumah pressure must be reduced with no appreciable delay. This test demonstrates the elements of testing technique used for the entire series.

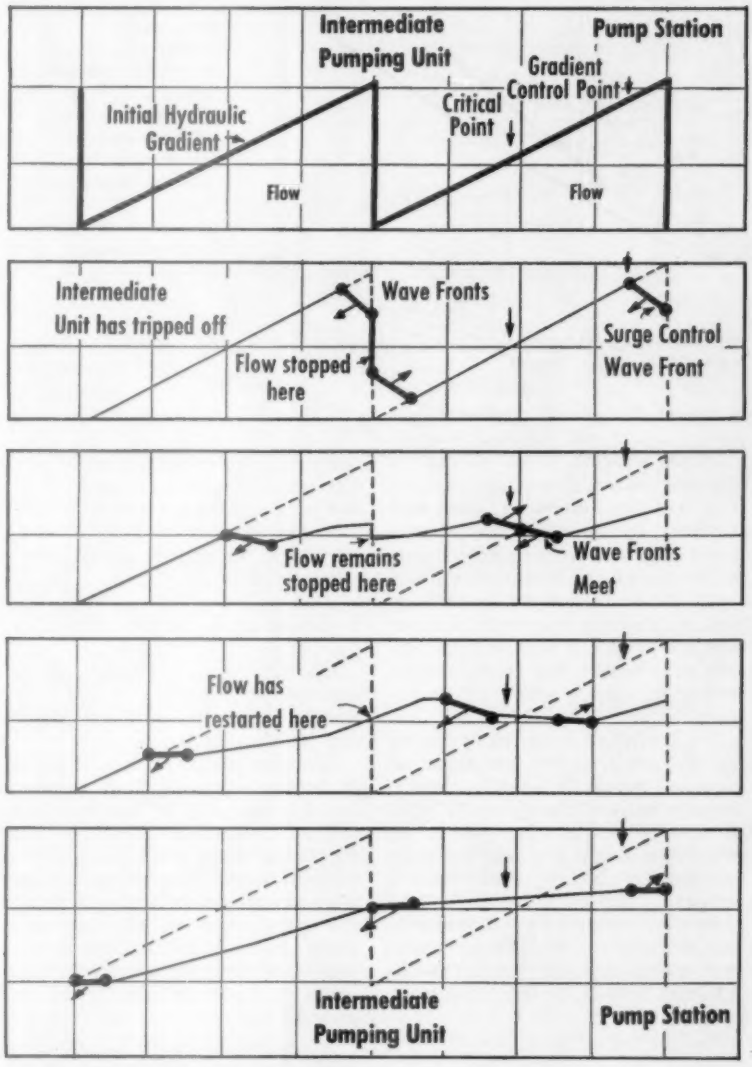
Interpreting experimental data. In the earlier stages of testing, data were obtained under a variety of initial conditions, generally with operating pressures reduced to insure safety to the pipeline. This procedure, of course, required that the data be analyzed and extrapolated to predict results over the full range of operating conditions.

The problem of analysis was intensified because in areas of the Region B type, the rarefaction wave meets the oncoming surge wave front at the critical locations on the pipeline, as shown in Fig. 6. Both the high-pressure wave traveling upstream and the rarefaction wave traveling downstream must be thought of as "extended" wave fronts which cover a distance of 15 to 20 miles each. The region where the two fronts meet is thus 30 to 40 miles in length.

Any critical point located in the downstream half of this region is subjected first to a pressure rise, then a pressure decrease. The initial rise is due to a fraction of the high-pressure front moving upstream. The time interval involved in the initial pressure rise can be readily computed because the velocity of travel of the fronts can be accurately measured.

But the magnitude of the pressure rise depends upon the attenuation of a fraction of the wave front. Wave-front attenuation, in turn, has been found to be a function not only of the magnitude of pressure rise at the intermediate pumping unit but also rate of this pressure change, or the time during which the change takes place.

This last fact presented a difficulty because Ludwig's analytical method for computing attenuation assumes that an instantaneous pressure change



APPROXIMATE PRESSURE DISTRIBUTION with surge control at progressive time intervals after intermediate pumping unit trips off. Fig. 6.

occurs at the wave front and does not provide for handling a more or less gradual pressure rise within the front. Another aspect of the problem is that the pipeline under present study is operated at higher stresses than those used in the United States under the American Code for Pressure Piping, ASA B-31.4-1959. This fact adds emphasis to the need for accuracy in the method of calculating pressure-wave attenuation.

For these reasons an extension of the mathematical development was undertaken to compute wave-front attenuation for the general cases arising from gradual pressure change.

The solution must satisfy the basic partial differential equations for turbulent flow, which may be written in terms of dimensionless variables as follows:

$$\pm \frac{\partial P}{\partial X} = V^n + \frac{\partial V}{\partial T} \qquad (1)$$

$$\pm \frac{\partial P}{\partial T} = \frac{\partial V}{\partial X} \qquad (2)$$

in which the plus sign is used if distance ratio, X, is measured positively in the direction opposite to flow and the minus sign is used if X is positive in the direction of flow. The dimensionless ratios are defined at the end of the text in Appendix 1 and are equal to those defined by Ludwig. Each is proportional to a true variable, i.e., P for pressure, V for velocity, T for time, and X for distance along the pipeline.

Pressure can be eliminated from Equations 1 and 2 by taking the second mixed partial derivative of P with respect to X and T in each equation. The resulting velocity equation is:

$$\frac{\partial^2 V}{\partial X^2} = nV^{n-1}\frac{\partial V}{\partial T} + \frac{\partial^2 V}{\partial T^2} \qquad (3)$$

In Equation 1, if the term $\partial V/\partial T$ were omitted, the remaining equation would represent the friction loss in a pipeline, with pressure loss per unit length of pipe being proportional to the nth power of the flow rate, represented by V^n. The exponent, n, is usually taken as 2.0, although this is somewhat in error for most practical pipeline systems, in which the exponent can be as low as approximately 1.70. This is a refinement which will be considered later. For this present case, the exponent will be taken as 2.0 because the mathematics is simplified.

It can be shown that a steady-state flow condition is described in the dimensionless ratios by the relations:

$$V = 1$$

$$P = X + P_o$$

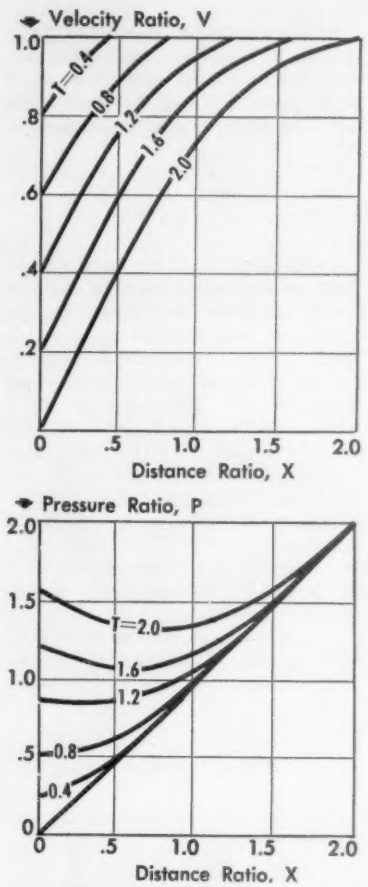
where P_o is the dimensionless ratio for the initial steady pressure at the downstream end of the line, at which $X = 0$. Of course, differences in pipeline elevation must be converted to dimensionless pressure and added or subtracted to the above relation for P to obtain corrected values.

The solution will be handled in two parts: numerical and analytical.

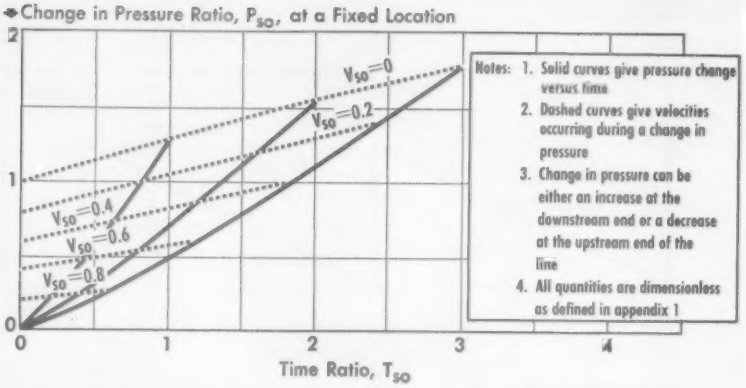
The numerical solution offers possibilities for solving any problem in either increasing or reducing turbulent flow, including the attenuation of traveling wave fronts and pressure distribution in the pipeline system in the region in the wake of a wave front. However, because of the labor involved, all possible cases of increasing and decreasing flow have not been computed for presentation here.

The numerical method used here can be used with a reasonable amount of labor to solve manually any specific case desired and it could be readily applied on a digital computer to solve all practical cases of increasing or decreasing flow in dimensionless terms applicable to any pipeline problem.

From the present problem of reducing turbulent flow, Fig. 8 shows graphically the result of the numerical solution. At $X = 0$, the pressure



NUMERICAL SOLUTION for velocities and pressures versus distance; turbulent flow is stopped at a uniform rate in time $T_{so} = 2.0$ at $X = 0$. Fig. 7.


Change in Pressure Ratio, P_{so}, at a Fixed Location
2
1
0
$V_{so}=0$
$V_{so}=0.2$
$V_{so}=0.4$
$V_{so}=0.6$
$V_{so}=0.8$
0
1
2
3
4
Time Ratio, T_{so}
Notes: 1. Solid curves give pressure change versus time
2. Dashed curves give velocities occurring during a change in pressure
3. Change in pressure can be either an increase at the downstream end or a decrease at the upstream end of the line
4. All quantities are dimensionless as defined in appendix 1

PRESSURE-TIME-VELOCITY relations are shown with numerical solution for decreasing turbulent flow. Fig. 8.

is changed with time along one of the solid lines in the graph, or along any interpolated line. The dashed lines indicate the velocities encountered during the pressure change. The entire solution is based upon flow rates being reduced at uniform rates, or V changes linearly with time. These PVT relations apply to any fixed location on the pipeline.

The numerical solution has been carried only far enough to obtain Fig. 8, but in this computation it was necessary to find values of P and V over a considerable distance, X, which thus gives pressure and velocity distribution curves in this region. Fig. 7 shows these curves for the case in which turbulent flow is stopped in time $T_{so} = 2.0$. In an unpublished paper, Krahula[4] obtained essentially identical results as shown in Fig. 8 by use of an entirely different numerical method.

The second part of the solution is analytical. For turbulent flow, Equations 1 and 3 are nonlinear and an analytical solution is not necessarily available. However, one set of solutions has been found by using trial functions and these give the attenuation of extended traveling-wave fronts. As mentioned, the numerical solution could also be carried out for attenuation of traveling-wave fronts. However, the analytical solutions give this with considerably less effort, subject to their limitations, which will be discussed later.

The derivation is started by assuming that the transient component of pressure change is linearly proportional to velocity change at the point of observation. In other words, an observer traveling at acoustic velocity and situated at any point within a traveling wave front would "see" a transient component of pressure change and a velocity change linearly proportional to each other. This assumption is given by the relation:

$$P = A(1 - V) + X + P_o \quad (4)$$

The term, $A(1 - V)$, is the transient component of pressure, later called P_s. The constant, A, is unity for a case of instantaneous pressure change. But for a gradual change, A is greater than unity.

From Equation 4, the partial derivatives of P with respect to X and T are written:

$$\frac{\partial P}{\partial X} = -A\frac{\partial V}{\partial X} + 1$$

$$\frac{\partial P}{\partial T} = -A\frac{\partial V}{\partial T}$$

These are substituted into Equations 1 and 2 to eliminate P as well as either T or X. The two results are:

$$\partial V/\partial X = [-A/(A^2-1)]\,(V^2-1) \quad (5)$$

$$\partial V/\partial T = [1/(A^2-1)]\,(V^2-1) \quad (6)$$

Integrating Equation 5 gives V as a function of X plus an arbitrary function of T and the constant of integration. The function of T is found by integrating Equation 6, and the combined result is:

$$V = \tanh\,[(AX-T)/(A^2-1) + C] \quad (7)$$

Equation 7 is a solution to the simultaneous Equations 1 and 2 for turbulent flow and it is also a solution to Equation 3.

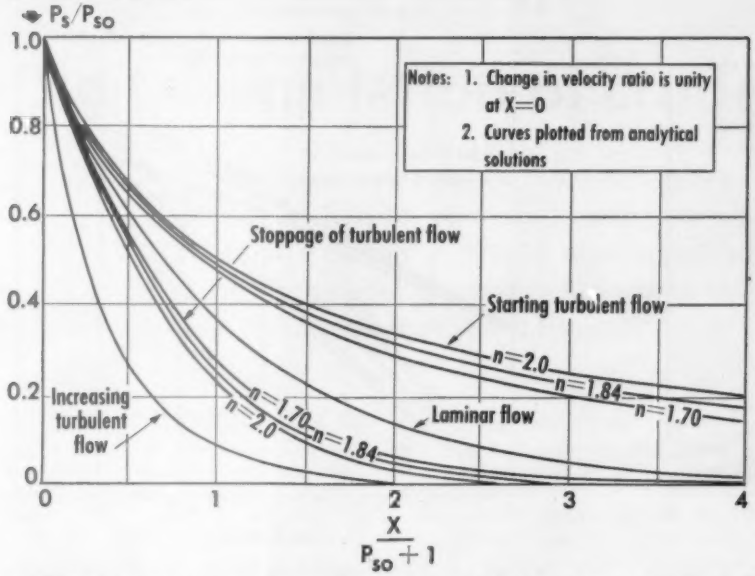
The solution, Equation 7, is limited in usefulness because it is necessary for the argument of the hyperbolic tangent to approach infinity in order for V to become unity, its initial value. However, the solution does meet boundary conditions needed in finding the attenuation of traveling-wave fronts. In the latter case, an observer who starts from the end of the pipeline and travels at acoustic velocity with the wave front would observe a velocity ratio of $V = V_{so}$, less than unity at $X = 0$ and would "see" V approach unity as X approaches infinity.

Also, if the surge pressure is linearly proportional to the change in velocity as given in Equation 4, then the observer would "see" an initial surge pressure of say $P_s = P_{so}$ at $X = 0$; and then traveling with the wave front he would observe P approach the initial gradient, $P = X + P_o$ as X approaches infinity. The foregoing statements can be summed up mathematically as boundary conditions:

$$\text{at } T = T_{so} \text{ and } X = 0;\ V = V_{so},\ P = P_{so} + P_o$$

$$\text{at } T = X + T_{so},\ V = V_s,\ P = P_s + X + P_o$$

These conditions inserted into Equation 7 give the particular solution:



ATTENUATION OF maximum wave front pressures after starting or stoppage of flow. Fig. 9.

$$V_s = \tanh \left[\frac{X(1 - V_{so})}{P_{so} + 1 - V_{so}} + \tanh^{-1} V_{so} \right] \quad (8)$$

And from Equation 4, the transient component of P will be called P_s:

$$P_s = \frac{P_{so}}{1 - V_{so}} \left[1 - \tanh \left(\frac{X(1 - V_{so})}{P_{so} + 1 - V_{so}} + \tanh^{-1} V_{so} \right) \right] \quad (9)$$

to which the initial gradient $P = X + P_o$ must be added to obtain the total value of P at the wave front.

In case the flow is completely stopped at $X = 0$, so that $V_{so} = 0$, the maximum surge pressure at the peak of the traveling wave front is:

$$P_s = P_{so} [1 - \tanh (X/P_{so} + 1)] \quad (10)$$

This equation is plotted as one of the curves of Fig. 9, which is presented principally to show a comparison of the wave-front attenuation for the various cases.

In Equations 8 and 9, the values V_{so} and P_{so} are those reached at the starting point of the wave front, $X = 0$, after an interval of time $T = T_{so}$, during which the initial pressure change has taken place.

The combined numerical and analytical solutions for reducing turbulent flow can be used for either a case of raising pressure at the downstream end of the line or one of lowering the upstream pressure, either of which would reduce flow rate. Thus in Fig. 8 and Equations 8, 9, and 10, P_{so} can be regarded as change in pressure in a way to reduce the flow and P_s is the transient component of pressure in the wave front which can be traveling upstream and above the initial gradient or a wave traveling downstream below the gradient.

However, since the problem is nonlinear, the principle of superposition cannot be applied. This means that the initial gradient, in this problem, is an essential part of the solution. The cases of increasing turbulent flow, starting from either a static or a flowing condition, are thus entirely separate problems and must be solved independently.

The laminar-flow problem, on the other hand, is linear because the frictional resistance to flow is proportional to the first power of velocity in Equation 1. Thus the transient components of P and V can be isolated to generate a solution; then an initial gradient can be added into the final result if a gradient exists.

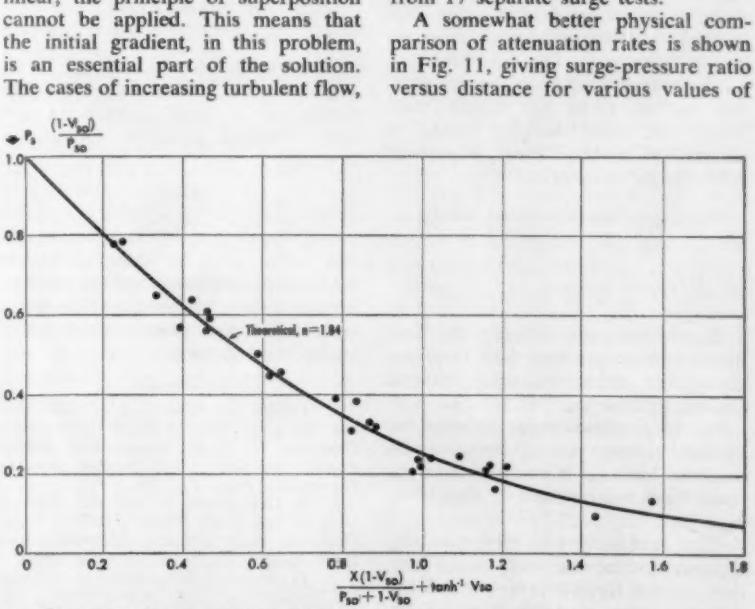
Fig. 9 summarizes the analytical solutions for laminar flow and for increasing or decreasing turbulent flow.

With these solutions in hand, the procedure for correlating experimental data has made use of the numerical solution at $X = 0$ to determine the surge velocity, V_{so} from Fig. 8, corresponding to the measured value of P_{so} and a known value of X for remote location to substitute in Equation 9 and find the surge pressure P_s at the remote point.

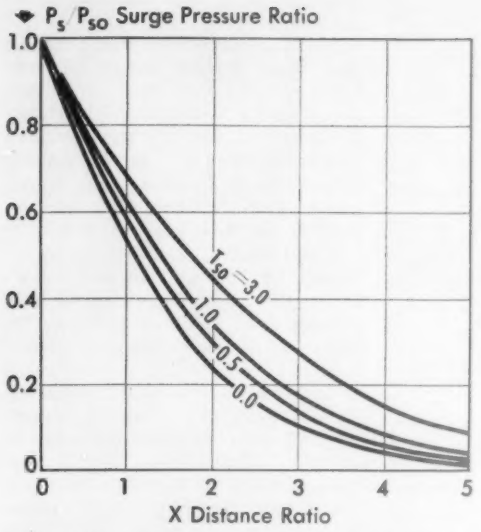
A refinement in Equation 9 for wave-front attenuation was made to correct for the fact that fluid friction in a large-diameter pipeline is not exactly proportional to the square of velocity. For the 30-31-in. pipeline on which this report is based, a representative value of the exponent is $n = 1.84$, and this is the curve actually being used for prediction of surges under all conditions.

The use of this type of curve has the advantage of permitting direct comparison with the test data for all the various conditions and locations. This is illustrated in Fig. 10 on which is plotted pressure-wave attenuation from 17 separate surge tests.

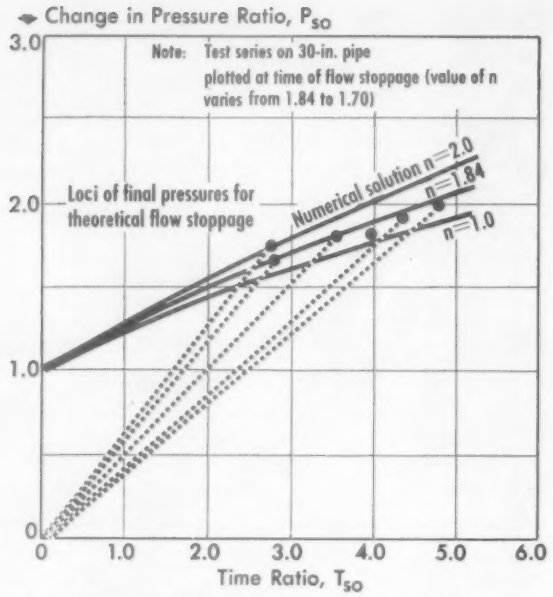
A somewhat better physical comparison of attenuation rates is shown in Fig. 11, giving surge-pressure ratio versus distance for various values of



COMPARISON OF MEASUREMENTS with theoretical attenuation of surge pressures in traveling waves for reduction of turbulent flow after station shutdown. Fig. 10.



COMPARISON OF SURGE attenuation for extended wave fronts after flow stoppage. Fig. 11.



PVT RELATIONS COMPARISON of theoretical and experimental results for gradual flow stoppage. Fig. 12.

T_{so}, the time taken to stop flow at $X = 0$. These curves can be used directly only if flow is stopped at $X = 0$. This shows that attenuation is less rapid for larger values of T_{so}.

Fig. 12 gives results of a few tests in which turbulent flow was stopped by slowly reducing the discharge pressure at a pump station. During the tests, the exponent, n, would start from approximately a value of 1.84, then reduce to 1.70 and eventually 1.0 (laminar) just before complete stoppage. Test results appear to correlate reasonably well with numerical solutions for pressure change required to stop the flow in various time intervals, with n = 1.0, 1.84 and 2.0.

The bulk modulus used in the analysis is that given for Mixed West Texas and New Mexico Crude in Section III of the "Final Report of Joint Surge Conference."[5]

For a pipeline restrained axially:

$$K_e = \frac{k}{1 + kd/Eh\,(1 - \gamma^2)}$$

T_{so} is time ratio defining the time during which pressure and flow are changed to establish a wave front at a given location such as $X = 0$.

P_{so} is pressure ratio defining the pressure change taking place at the location, such as $X = 0$, where the wave front is generated in time $T = T_{so}$.

(For a reduction in flow rate, P_{so} represents either an increase in pressure at the downstream end of the line or a pressure decrease at the upstream end.)

P_s is transient component of pressure in a wave front at any location.

V_{so} is final velocity ratio reached when $T = T_{so}$ and $P = P_{so}$ at the end of the line where the wave front is generated. V_s is velocity reached in the wave front at any location.

Basic partial differential equations of unsteady flow are as follows:

$$\pm \frac{\partial p}{\partial x} = \frac{p'}{(v')^n} v^n + \frac{\rho}{g} \frac{\partial v}{\partial t}$$

$$\pm \frac{\partial p}{\partial t} = \frac{\partial v}{\partial x}$$

The quantities p′ and v′ are both constants which combined to form the coefficient of fluid friction in the more familiar equation for steady flow:

$$\frac{P}{x} = \frac{p'}{(v')^n} v^n$$

The value of n in these studies is taken from familiar graphical plots of friction factor versus Reynolds number for the pipe diameter and range under consideration.

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APPENDIX 1

Definitions of terms and dimensionless ratios:

P is $pg/a\rho v'$.
V is v/v'.
T is $tp'g/v'\rho$.
X is $xp'g/a\rho v'$.
t is time, seconds.
p is pressure, psf.
v is velocity of flow, ft./second.
x is distance, ft.
g is acceleration of gravity, ft./second.^{2}
p′ is initial pressure gradient, psf./ft.
v′ is initial liquid velocity, ft./second.
ρ is liquid density, lb./ft.^{3}
a is acoustic velocity, ft./second.
K_e is effective bulk modulus of liquid and pipe, lb./ft.^{2}
k is bulk modulus of liquid, lb./ft.^{2}
d is pipe diameter, ft.
h is pipe-wall thickness, ft.
E is modulus of elasticity for pipe material, lb./ft.^{2}
γ is Poisson's ratio for pipe material (0.30 for steel).

Acoustic velocity:

$$a = (K_e g/\rho)^{1/2}$$

Digital simulation of crude-oil pipelines

• Computer programs are presented for the design, operation, and economic analysis of crude-oil pipelines. Included are automatic-control simulation, two-phase flow design, hydraulic representation of a multistation pipeline recognizing line profile, operation of a heated oil line, and optimizing power costs for a multistation trunkline.

BY T. R. YOUNG

. . . who joined Shell Pipe Line Corp. in 1951 and since 1955 has been engaged in applying electronic computation to economic and technical problems. A 1943 chemical-engineering graduate of University of Michigan, he has done aviation-fuels research for The Texas Co. (now Texaco Inc.) and was in the industrial-research program of University of Wichita.

MODERN METHODS of analysis and improved stored program computing equipment for pipeline simulation show many fields of fruitful application.

But the development of electronic computation as a management tool has been impeded by the jargon used by the computing fraternity. The resulting communication barrier has made exploitation of the computing art difficult and often inefficient.

Recent work of a computing group serving a major crude-oil pipeline company is reported here in terms understandable to management and to the general engineering staff.

These computer programs represent improvement in engineering practice in several ways: (1) solution of problems not possible by traditional methods, (2) increased accuracy of analysis through the elimination of simplifying assumptions characteristic of traditional practice, and (3) reduction of professional technical labor required.

Design Simulation

Automatic-control simulation. The Ozark Pipe Line System operated by Shell consisted of a 10-station trunkline with 5 remotely controlled stations and 5 manned stations in 1959. The remotely controlled and manned stations are in alternating sequence.

We wanted to further automate this system and, due to dispatcher overload, a 0.5% communication-outage, and false-signal experience in the remote-control system, an alternative control system was conceived. The new system was designated a "power-level controller" and has the distinguishing characteristic of fully automatic local-station control requiring no communication with a central control point.

Because of the novelty of the power-level-control concept, we had to be sure before installation that the system would be fully operable and free of major fault.

A computer simulation was therefore developed for the action of the proposed control system in conjunction with the pipeline system. Initial data were obtained using an analog simulation. The analog representation did not give information on the sequence of operations under power-level control, and the digital simulation was made to determine this information. In particular, it was necessary to determine controller set-point values which would assure freedom from oscillation of control action.

The Ozark system is a 438-mile, 22-in.-diameter line with throughput of approximately 270,000 bbl. a day. Each of the 10 stations is equipped with four pump units of approximately relative sizes ½, 1, 1, 1, giving the opportunity for stepped pressure incrementation, as all units are fixed-speed drive.

The stepped combinations are called "power levels." Consequently, "increasing the power level" at a station means adding pressure boost by bringing a half unit on the line or dropping a half unit and adding a full unit. Line-rate adjustment is made by a combination of pressure stepping and station throttling.

The specific controller duty for computer simulation included line startup and recovery from line upset due to forced pump unit or station shutdown. For both situations we wanted to know that the local automatic-control action would lead directly, without hunting, to a stable operating condition for all stations.

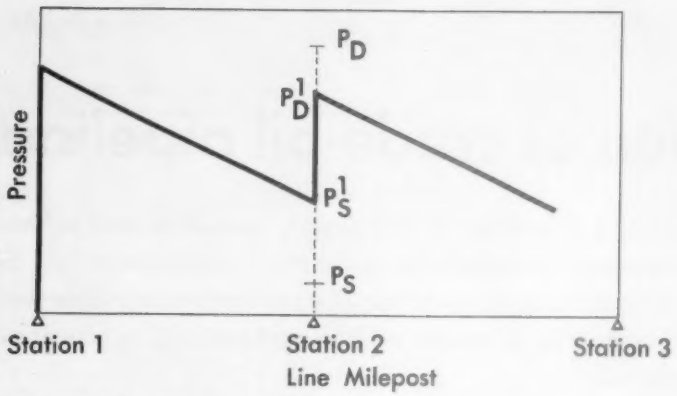
For the simulation of line startup the following operations are performed by the computer:

Step 1: Maximum power level to be permitted at each station is read into the computer along with a starting operating pressure for the initial station on the line. (The values for the maximum power levels at the different stations, in practice, would be read into the individual station controllers manually or by remote communication from the dispatching office at the beginning of the month.)

Step 2: The pressure boost at the first station initiates line flow at a rate determined by the first station pressure boost and its attenuation by line friction, station loss, and static head effects. The determination of this rate requires a trial-and-error solution based on the relation between required pressure boost and pressure developed by active pumping units. (The control-simulation program contains tabular representations of all centrifugal pump head-capacity curves.)

Step 3: Resultant suction and discharge pressures at each station are

Presented at annual pipeline conference, API Division of Transportation, Tulsa, April 28-29, 1960.



Controller will indicate a power level increase if the following conditions are found true:

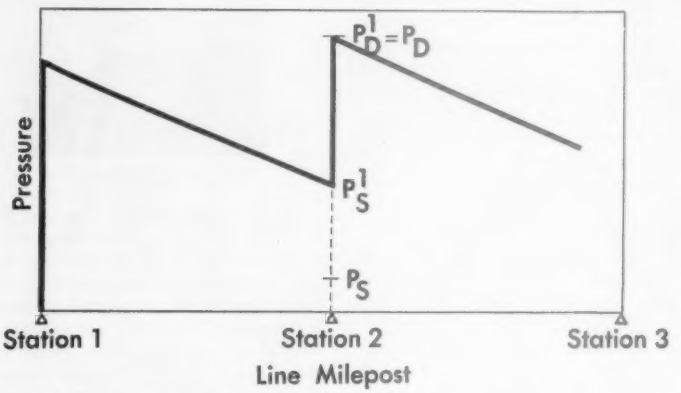
$$P_D - P_D{}^1 \geqq K_1 \text{ and } P_D{}^1 < P_D$$

$$P_S{}^1 - P_S \geqq K_2 \text{ and } P_S{}^1 > P_S$$

Where:

P_D = maximum permissible discharge pressure
$P_D{}^1$ = computed operating discharge pressure
P_S = minimum permissible suction pressure
$P_S{}^1$ = computed operating suction pressure
K_1, K_2 = arbitrary controller set points

CONTROLLER LOGIC for power incrementation is shown in schematic illustration. Fig. 1.



Controller will indicate a power level decrease if either of the following conditions is found true.

(a) $P_T \geqq K_T$
(b) $K_T > P_T > K_T{}^1$

Where:

P_T = throttling pressure ($= P_C - P_D{}^1$)
$K_T, K_T{}^1$ = arbitrary controller set points
P_C = final pump case pressure
$P_D, P_D{}^1, P_S, P_S{}^1$, as in Fig. 1.

CONTROLLER LOGIC for power decrementation with station throttling on discharge. Fig. 2.

then determined by direct computation.

Step 4: For those stations at which computed suction and discharge pressures are not within specified limits, station throttling is incremented by an amount proportional to the amount of suction or discharge pressure lying beyond operating limits.

Step 5: The line is then rebalanced as in Step 2, e.g., a line rate is determined, by trial and error, that generates a line friction loss just able to dissipate fully (when combined with station losses and static-head effects) the generated pressure boost from active pumping units. The throttling incrementation (or decrementation) is repeated as in Steps 2-4 until all station suction and discharge pressures have been brought within specified operating limits.

Step 6: Each station is then examined for possible reduction or increase in power level according to controller logic, after which the above sequence is resumed.

An illustration of controller logic is shown in Fig. 1 for power-level incrementation and in Fig. 2 for power-level decrementation.

This detailed action of the control system on the line stations is pursued until all stations have reached preset maximum power levels. This completes the simulation of line startup.

The principal additional functional test of the power-level control action was for recovery from line upset. The test was accomplished in the computer program by line startup modified to simulate forced shutdown. Following startup, new input data are read by the computer. The new data, in effect, cause shutdown of one or more selected stations by forcing their power levels to zero.

Following this forced shutdown, the normal power-level incrementation/decrementation process is executed until stable line operation is secured. The efficiency of line recovery after a simulated station shutdown can be found by observing the pattern of power-level adjustment and throttling action. If direct, noncycling throttling and power-level adjustment lead promptly to stable line operation, control action may be considered acceptable.

The exact behavior of the control system and the accompanying hydraulic conditions in the pipeline are reported by the computer at each significant step in bringing the line up. This intermediate data printout occurs at each power-level change. Any tendency for overcontrol, hunting, or other unstable control behavior can be detected easily.

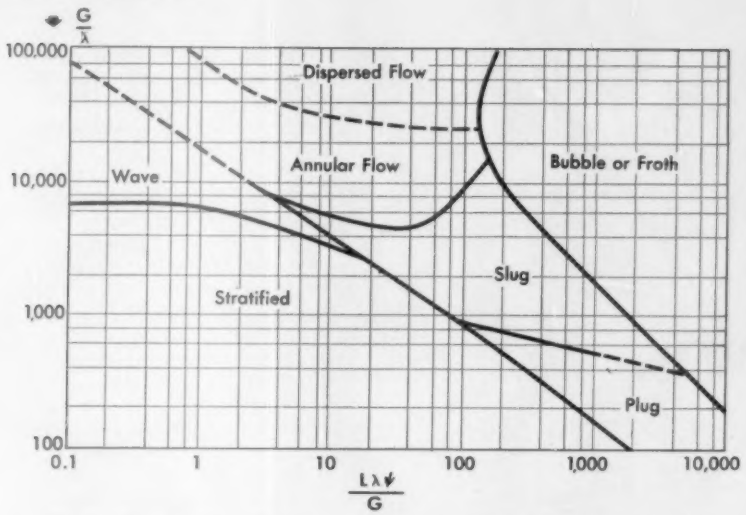
The practical use of the simulation program consisted in the trial use of alternative ideas for controller logic to govern power-level incrementation and decrementation. After a satisfactory set of rules for control logic had been found, the simulation work was completed by the determination of values for the controller set points represented by the constants K_1, K_2, and K_T in Figs. 1 and 2.

The resulting power-level controller design was built as a prototype, installed in the Grand Lake Station of the Ozark Pipe Line System, and performed as predicted. Extensive operational testing of the system, including forced adjacent station shutdown, failed to develop malfunction in the power-level control operation.

Two-phase flow simulation. The simultaneous flow of gas and liquid in a pipeline as separated phases has never been subjected to an analysis leading to a practical and reliable design procedure. The basic objective is the prediction of line pressure drop when gas and liquid rates are specified.

The problem is of importance in the case of wet-gas transmission lines in which condensate may separate, producing a small volume of liquid phase, in crude-oil lines carrying free gas as an extra service; and in some process-transfer lines in which flashing vapor produces a substantial gas phase.

The complexity of the problem may



FLOW-PATTERN regions are shown in flow-type correlations. Fig. 3.

be appreciated when it is realized that two-phase gas and liquid flow may occur in any of seven different types—dispersed, wave, annular, stratified, plug, slug, and froth.

Successful research directed toward the development of a sound two-phase-flow design procedure will have to employ automatic computation. Such high-speed computation will enable the comparison of any given design-correlation prediction against a large body of diversified experimental data. Only such massive computation is expected to permit ultimate confirmation of some future correlation as adequate for general design purposes.

The computer simulation of the two-phase-flow phenomenon for design purposes discussed below is based on the correlation of Baker.[1]

Problems involved in the computation include the line-pressure drop (to be determined) which itself determines the amount of gas dissolved in the liquid phase, hence the gas-liquid ratio. In addition, the amount of dissolved gas determines the physical properties of the liquid phase, viscosity, density, and surface tension. All of these pressure-dependent factors are used themselves for the determination of the internal line pressure, thus forcing a trial-and-error solution.

The problem is further complicated by the known possibility of several types of flow, most of which have been correlated by different empirical equations. Baker has met the problem by developing a flow-type correlation shown in Fig. 3.

In use, the correlation parameters $L\lambda\psi/G$ and G/λ are computed based on liquid and gas flow rates and physical properties. (The physical properties of gas and liquid are represented in the computer by suitable equations or numerical tables.) The pair of coordinates thus found then locate a point in one of the flow-type regions of the correlation graph, Fig. 3. With the flow type identified, the selection of the associated pressure-drop equation is possible and the latter used for the calculation of two-phase pressure drop.

The computation sequence can be described briefly as follows:

Step 1: Read input data describing the line, gas, and liquid rates, and physical properties.

Step 2: Compute the physical properties of gas and liquid phase using an appropriate assumption for line pressure, as these properties are dependent upon pressure. Initially, the assumed pressure is the given inlet line pressure.

Step 3: Compute the values for $L\lambda\psi/G$ and G/λ which are determined by gas and liquid rates and fluid physical properties. The values of $L\lambda\psi/G$ and G/λ are then used as indices to the graphical correlation of Fig. 3 to determine the flow type most likely present in the line. In the computer, Fig. 3 is represented by a two-way table lookup operation. The identification of the flow type is then used to select the pressure-drop equation governing that type of flow.

Step 4: Compute the two-phase pressure drop over the line length. Compute the average line pressure and compare with the previously assumed average line pressure used for the evaluation of physical properties. If the assumed and calculated average line pressures are different by more than a prescribed maximum, the computed line pressure is taken as a new assumption and Steps 2-4 are repeated.

Step 5: Compare the computed two-phase line-pressure drop with 10% of the computed terminal line pressure. If the pressure drop is greater than the 10% value, break the line length into as many segments as necessary to produce an estimated pressure drop over each no greater than 10% of the estimated terminal line pressure. This segmentation is necessary to insure that the assumed line pressure used at any point for computation of physical properties and gas-oil ratio is not appreciably different from that actually present in the line.

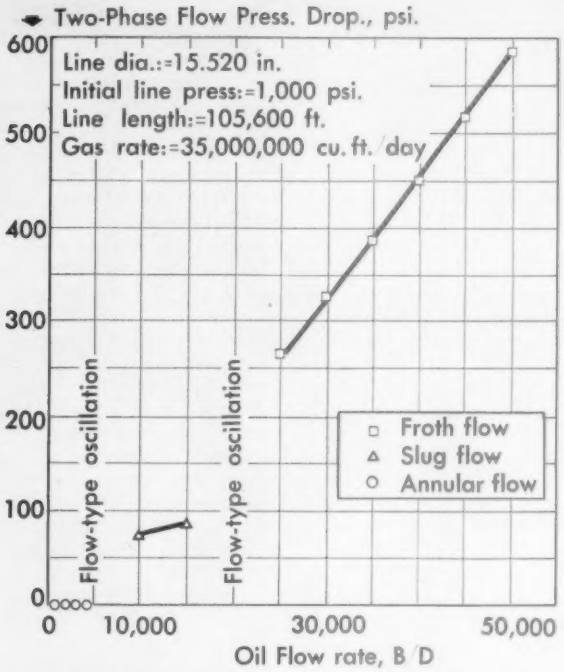
Step 6: If segmentation has been necessary, repeat the procedure of Steps 2-4 for each segment and add the segment pressure drops to find the two-phase pressure drop over the entire line.

As boundaries separating different types of flow are encountered in the systematic increase of either the gas or oil rate, flow-type oscillation may occur. This is purely a computational phenomenon that arises in the following manner. On an assumed line pressure one computes the flow type, which may be, e.g., slug flow. On the next trial, using an adjusted assumed line pressure, the calculated flow type may be froth. The next iteration may return to slug flow, and so on. This type of oscillation may continue indefinitely prohibiting a final calculation of line-pressure drop. Under these circumstances the computer program produces an error signal that identifies the trouble and goes to the next line-rate case.

The occurrence of oscillation simply signals a boundary condition between flow types, warning that extrapolation into the flow range involved is subject to the hazard of indeterminate flow type. A similar situation exists in single-phase oil flow between Reynolds numbers of 1,000 and 2,000.

The preceding calculation leads to a single pressure-drop value. The information of practical importance generated by the program is, of course, the usual characteristic line-pressure curve for varying rates of both gas and oil throughput.

Illustrative plotted output data from the program are shown in Fig. 4 where pressure-drop values are given for 16-in.-diameter pipe over an oil-rate range of 0-50,000 bbl. daily at a gas rate of 35 M.M.s.c.f.d. For this selection of input data, three types of flow are found to exist at different values of the data-annular, slug, and



ANNULAR-SLUG-FROTH flow in 16-in. pipeline. Fig. 4.

froth. Pressure-drop values at 5,000 and 20,000 bbl. daily were not obtainable due to the occurrence of the flow-type oscillation discussed above.

Operational Simulation

Operating control of a heated oil line. In the development of an operating guide for a heated line, an unexpected characteristic of such lines was developed on the basis of extensive computational analysis of the problem; it greatly simplifies operational control of the line in question and possibly others.

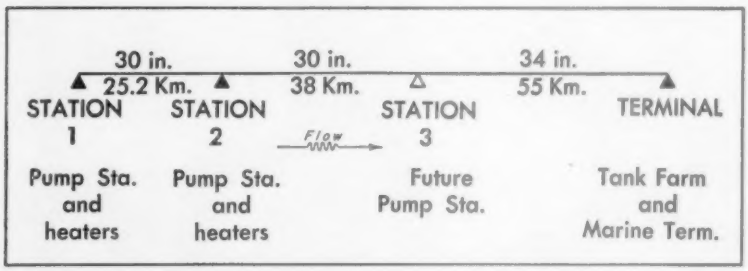
The problem was as follows: Develop a simple operating guide for dispatching use to govern the selection of pumping pressures for a heated crude pipeline. Some system details are shown schematically in the sketch of Fig. 5. The line is 118.2 km. in length and of two diameters, 30 and 34-in. Projected line rate is 310,000 to 490,000 bbl. daily. Pumping and heating stations are located as indicated in the figure.

The general method of solution was the generation of a set of tables showing the required line-friction pressure loss as a function of line throughput, inlet temperature of the oil for each crude pumped and for each line diameter involved.

The variables to be recognized in computing pressure drop for a heated oil line include the line diameter, oil rate, oil thermal conductivity, soil thermal conductivity, wall heat-transfer coefficient, ambient temperature, inlet temperature of the oil, viscosity-temperature function for the oil, oil gravity, and the distance of oil travel.

These variables are related by the expression:

$$T_2 = T_A + \frac{T_1 - T_A}{e^{5.46XKd/\phi Q}} \qquad (1)$$



HEATED OIL pipeline system details. Fig. 5.

where:

T_1 = initial oil temperature, °F.
T_2 = temperature at a point along the pipeline at distance X, °F.
T_A = temperature of surroundings, °F.
X = distance, km.
d = pipe outside diameter, in.
e = napierian base.
K = average heat-transfer coefficient, B.t.u./ft.^{2}×hr.×°F.
ϕ = specific gravity of oil.
Q = line, bbl./hour.

The values assignable to the variables are known or may be assumed with acceptable accuracy with the exception of the soil thermal conductivity. This was determined experimentally by measurements along the right-of-way for the soil in place.

For computation, each line segment, the 30-in. and 34-in., was subdivided into 18 intervals over which soil conductivity was approximately uniform in value. These intervals were then used as computation intervals for which terminal line-temperature values were calculated by Equation 1. Temperatures at the beginning of succeeding intervals were taken as the previously calculated terminal temperatures. In this fashion a temperature profile was constructed for the line for which an example is shown in Fig. 6.

After determining both initial and terminal line temperatures for each interval, the average of the two was taken and stored in memory for the subsequent calculation of a viscosity profile for the line.

With a stored temperature profile in magnetic memory, a viscosity profile for the line was computed by the relation:

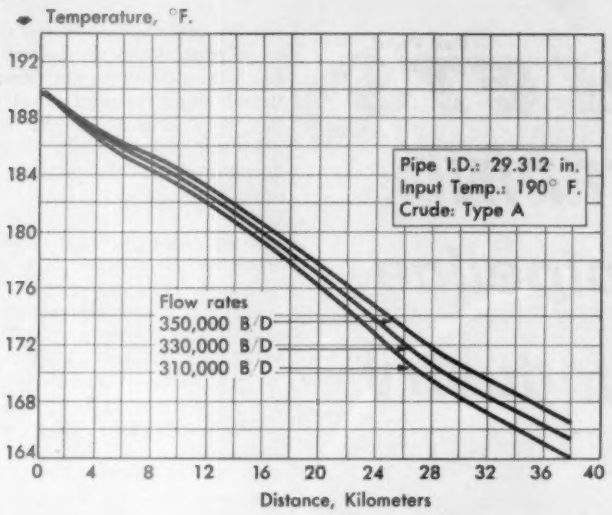
$$v = e^{(cT)^{-n}} \qquad (2)$$

where:

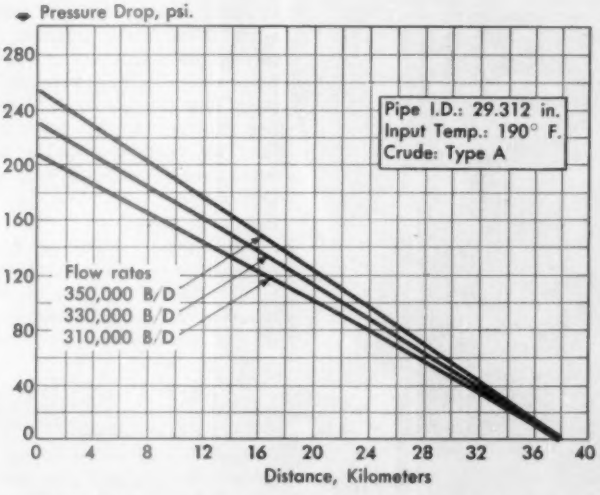
v = viscosity of oil, cs.
e = napierian base.
c = a constant characteristic of a given crude.
n = a second constant characteristic of a given crude.
T = temperature, °R.

With viscosity as a function of distance along the line available in memory, it was then possible to calculate friction pressure drop across each of the 18 computation intervals to develop a pressure-loss profile for the line segment. A plot of such a profile is shown in Fig. 7.

Inspection of numerous pressure-drop profiles indicated that the line-pres-



TEMPERATURE VS. DISTANCE is plotted for heated oil-pipeline system. Fig. 6.



PRESSURE DROP vs. distance for heated oil-pipeline system. Fig. 7.

sure drop for a given line diameter, crude, line rate, and input temperature was very nearly linear with distance, as is true in the common isothermal flow. This unexpected result permitted the tabulation of pressure-drop per kilometer values as a function of line rate, line diameter, and input temperature to produce a set of tables to be used by operating personnel in setting pumping pressures. The table format is shown in Table 1.

A set of 10 tables covering 2 line diameters and 5 crude types can be used to supply pressure-drop values for evaluating the expression:

$$P=\Sigma L_i^{30}-\Delta P_i^{30} +\Sigma L_i^{34}-\Delta P_i^{34}+P_{PM} \qquad (3)$$

where:

i = identification number of a batch in the line.
P = pumping pressure, psi.
L_i^{30} = length of batch i that resides in the 30-in. line, km.
L_i^{34} = length of batch i that resides in the 34-in. line, km.
ΔP_i^{30} = table value of pressure drop for crude batch i in the 30-in. line, psi./km.
ΔP_i^{34} = table value of pressure drop for crude batch i in the 34-in. line, psi./km.
P_{PM} = required arrival pressure at the line terminal, psi.

Thus, the computer simulation of a heated line carrying different kinds of crude oil can be used to generate a set of operating tables that permit the daily or hourly setting of pumping pressures by dispatching personnel.

Hydraulic computation with profile. The problem: The hydraulic calculations required to determine the operating pressures and power requirements for a multistation pipeline over rough terrain are generally obtained by graphical procedures. For a detailed study of such a line where a number of stations are considered, the line profile is highly irregular, and pressure relief on downhill runs appears necessary, the graphical procedures are likely to be costly in manhours of labor required for the analysis.

We wanted to avoid the graphical labor required for such studies through

TABLE 1—HEATED-OIL PRESSURE DROP CORRELATED WITH FLOW RATE AND INPUT TEMPERATURE

Pipe I.d.: 33.250 in.
Crude: Type A*

FLOW RATE	PRESSURE DROP, PSI. PER KM. INPUT TEMPERATURE, °F.								
MB/D	130	140	150	160	170	180	190	200	210
490	28.319-0	19.098-0	13.450-35	11.471	10.568	9.784	9.102	8.503	7.976
470	27.400-0	18.508-0	12.882-32	10,698	9.858	9.129	8.493	7.936	7.445
450	26.482-0	17.920-0	12.395-27	9.947	9.168	8.492	7.902	7.385	6.929
430	25.566-0	17.334-0	11.948-22	9.432-47	8.501	7.876	7.331	6.852	6.429
410	24.651-0	16.749-0	11.590-14	8.920-42	7.854	7.279	6.777	6.335	5.945
390	23.740-0	16.168-0	11.176-12	8.436-38	7.231	6.703	6.242	5.836	5.478
370	22.830-0	15.589-0	10.836-6	8.037-32	6.740-51	6.147	5.725	5.355	5.027
350	21.924-0	15.014-0	10.528-0	7.667-27	6.232-47	5.612	5.229	4.892	4.594
330	21.020-0	14.442-0	10.157-0	7.337-22	5.845-42	5.097	4.751	4.446	4.176
310	20.120-0	13.876-0	9.791-0	7.059-16	5.518-35	4.713-47	4.294	4.019	3.776

NOTE: A number following a hyphen is the distance in kilometers from Station 2 to the point at which laminar flow (Re <1,000) begins; all other flow is turbulent.

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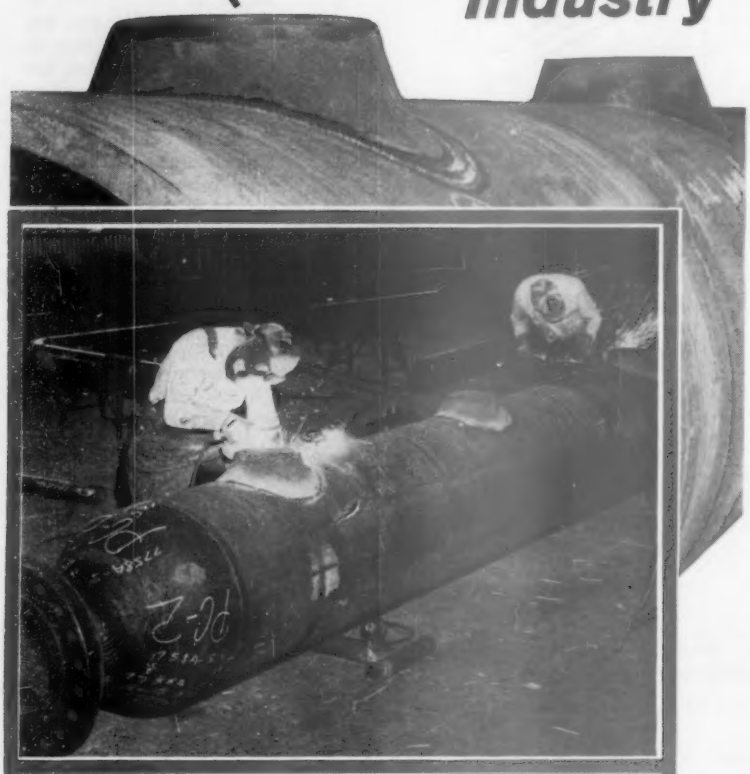

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the direct simulation of the operation of a generalized rough-terrain pipeline. In addition to the factors mentioned above, computational recognition was desired for the effect of extra-wall pipe (installed between given mileposts) on the permissible operating pressures in the line.

Other elements for recognition in the simulation included the usual restrictions on suction and discharge pressures. The line profile for simulation was to be represented by not more than 150 pairs of milepost-elevation coordinates. A maximum of 20 pump stations and 10 pressure relief stations was to be represented.

The simulation: The operational simulation is initiated with the usual data read-in which includes a set of not more than 20 throughput values for which individual station operating pressures and power requirements are desired as output.

The critical problem is determining a set of operating pressures for each throughput which will not violate suction and discharge-pressure restrictions nor the maximum permissible line pressure at any point along the line. In addition, sufficient line pressure should exist at all high points of the system to maintain the fluid in the liquid phase.

The forced violation of any of the pressure restrictions above by a particular throughput condition will be reported with identification of the type of pressure violation involved as well as its location.

The appearance of the output data from the simulator is shown in Table 2 for a single line rate.

The simulation is executed by a three-pass program with the second pass containing the fundamental hydraulic simulation of the pipeline.

In essence, the computer program examines each profile coordinate pair, starting with the first station, to determine the discharge pressure required to reach the given point on the line. Referring to Fig. 8, it can be seen that the discharge pressure to reach the first coordinate down-stream from Station 1 can be calculated as follows:

Multiply the pressure drop per mile associated with the given throughput times the line distance and add the pressure equivalent of the elevation at the coordinate point. The resulting required discharge pressure is designated $^{1}P^{1}$ where the leading superscript refers to the pumping station considered and the following superscript refers to the downstream coordinate point.

The examination of coordinate pairs

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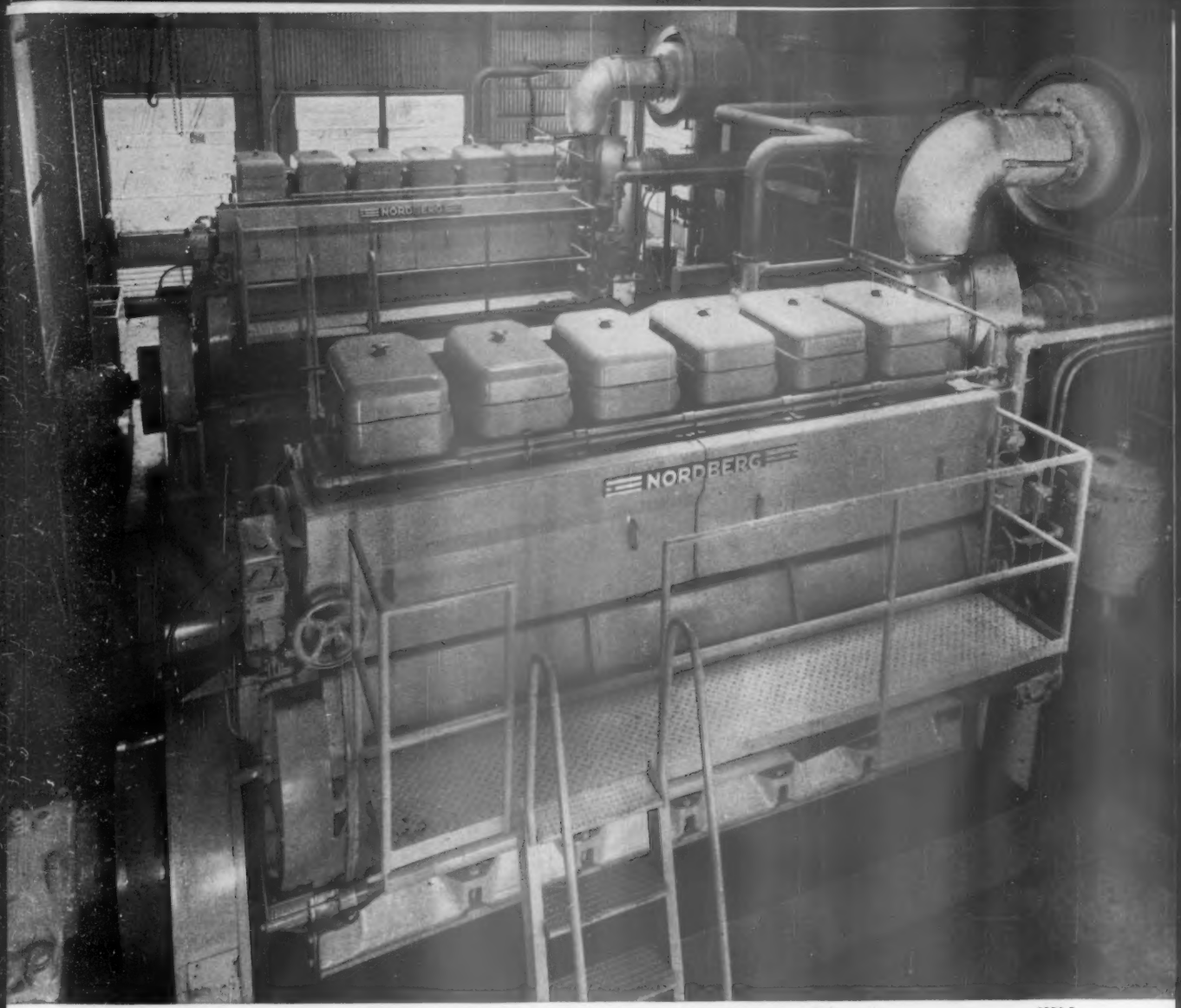

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TABLE 2—HYDRAULIC COMPUTATION WITH PROFILE PROGRAM NO. P35
THROUGHPUT 60,000 BBL. PER DAY

Pumping station No.	Suct. press psi.	Disch. press psi.	Net press psi.	Power req. B.HP.
1	0.0	581.0	593.5	7,567
2	25.0	671.0	658.5	8,396
3	0.0	0.0	0.0	0
4	338.2	663.0	337.3	4,301
5	250.0	610.6	373.1	4,757
6	25.0	734.4	721.9	9,204
7	25.0	801.6	789.1	10,061
8	142.0	0.0	0.0	0
Pressure-relief station No.				
1	587.0	48.8	525.7—	6,703—
2	571.8	60.8	498.5—	6,356—
3	839.2	204.8	621.9—	7,929—
Total power req.				44,286

proceeds systematically downstream and a required discharge at the upstream station is determined for each. In the calculation a constant pressure of 15-25 psi. is also added to the line loss and elevation values as a "vaporization control" pressure. This pressure is designed to maintain liquid phase in the pipeline at system high points.

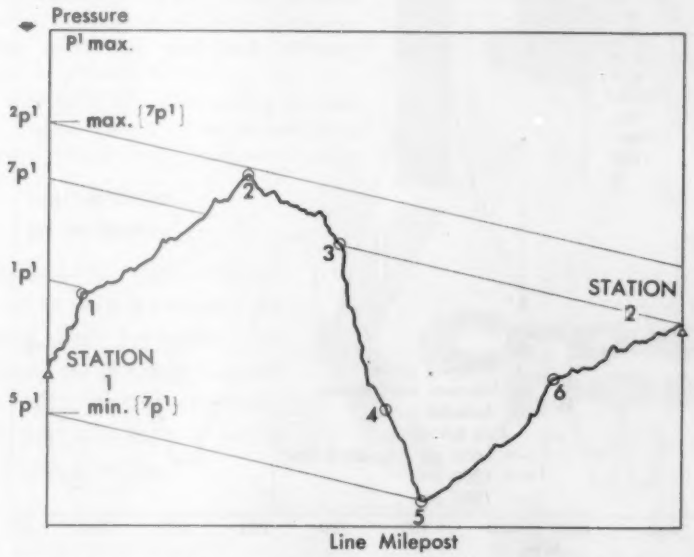
As the line-scanning process described proceeds to the next pump station, a record is kept of the maximum and minimum values of the computed discharge. It can be seen from Fig. 8 that the maximum value found, $^{2}P^{1}$, is the required discharge and that it in turn determines the value of the incoming suction pressure at the succeeding station. It is also seen that the difference between the maximum and minimum required pressures, $^{2}P^{1}$, $^{5}P^{1}$, is the value of the maximum pressure to which the line is subjected at any point between Stations 1 and 2.

If the maximum line pressure exceeds the standard pressure limit of the pipe (stored in memory), then the program makes a special interrogation of the coordinate point, number 5 in this case, to see whether extra-wall pipe is installed at this point (also a matter of record in magnetic memory).

If extra-wall pipe strong enough to contain the required operating pressure is in place, the throughput is accepted as operable. If the computed line pressure exceeds the line limit in any case, the throughput is rejected as inoperable and a special print-out occurs identifying the nature of the trouble and its milepost location.

The kind of inspection for violation of line-pressure restrictions just described is actually performed for each coordinate point on the line. This check guarantees that no part of the line will be subjected to excessive stress.

A requirement for a pressure-relief



BASIC ELEMENTS of hydraulic computation recognizing line profile. Fig. 8.

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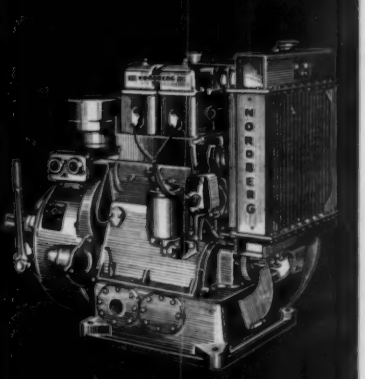

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station is recognized in the following manner. In examining line coordinates for line pressure exceeding line limit, when excessive pressure is detected a search is made upstream to determine whether a pressure-relief station location has been passed since the last pumping station.

If a pressure-relief station has been passed, it is brought into operation and serves to reduce line pressure just enough to avoid exceeding the line limit and at the same time preserve sufficient pressure to clear intervening high points.

The output of the simulation program is shown graphically in Fig. 9 which illustrates the capabilities of the program using a fictitious line profile.

Trouble arises at the 50,000-bbl.-daily rate at the first pressure-relief station, as it is necessary for the relief station to pull its discharge pressure below the vaporization-control pressure in order to deliver at the next pump station, Station E, at an acceptable suction pressure. The program output for the 50,000-bbl.-daily rate would identify the trouble and its location.

No trouble is experienced with the 100,000-bbl.-daily rate, and delivery to the terminal is physically possible. The 130,000 bbl. daily rate runs into trouble as the discharge pressure from the pressure-relief station immediately upstream from the terminal is required to be low enough to protect the line at the subsequent low elevations, forcing an indicated negative suction pressure at the terminal.

This type of information applies of course to projected pipelines, and can be of great value in the design of a new line. The simulation program is of further value in operations engineering in developing power and operating-pressure requirements at all stations as a function of throughput. Projections can also be made easily indicating the values of line rate at which successive stations will necessarily be brought into operation.

The computer running time for a simulation is approximately 25 minutes during which 20 throughput rates can be simulated for a 620-mile pipeline crossing the Rocky Mountains.

Economic Simulation

Optimization of power cost. The problem: The annual expenditure of approximately $1,500,000 for electric energy for pumping power on a pipeline system suggested itself as an appropriate subject for economic study.

The hydraulic duty defined by operating-pressure requirements offered a range of energy-consumption values at each station for a given throughput. In net effect, the distribution of energy use could be shifted from point to point along the system, within limits.

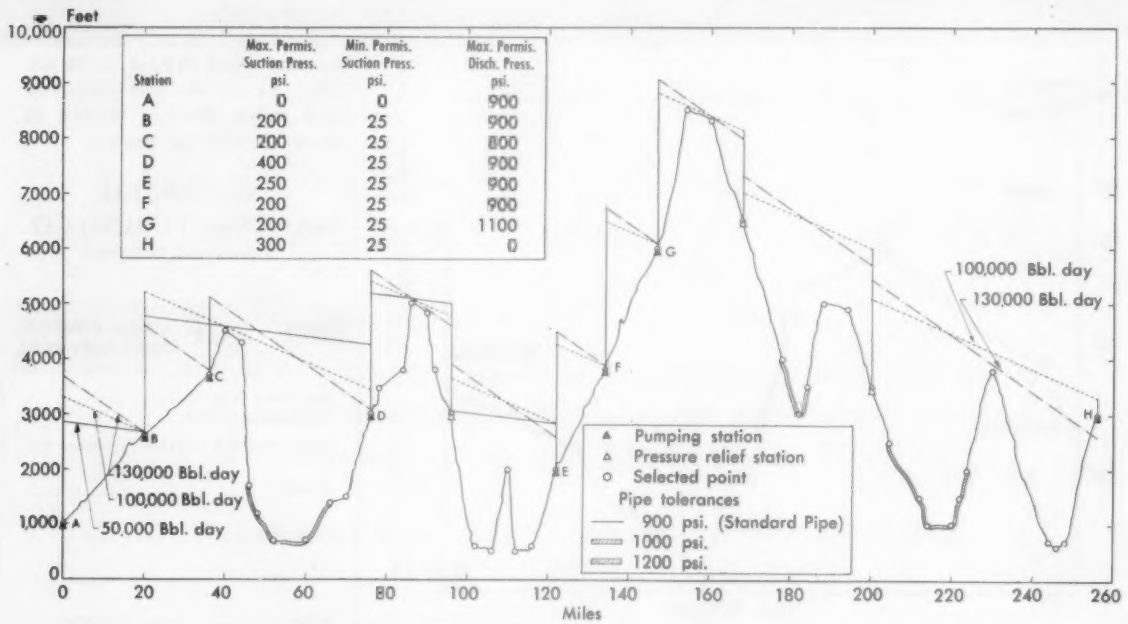
The problem was to determine the allocation of total energy requirement to be made to each of the several pump stations so that the total energy cost for a month of operation would be at a guaranteed minimum. The line itself is the same system described in the previous discussion of automatic-control simulation, a 10-station, 438-mile, 22-in.-diameter line carrying 240,000-280,000 bbl. daily.

The simulation program. The computer simulation was required to contain exact duplication of the principal features of the system. The line was represented by the usual parameters of interstation lengths, diameter, and elevations recognized at station locations.

The oil properties were approximated with a single representative viscosity and gravity. The stations were represented by a set of centrifugal pump head-capacity curves for the four pump units at each station. A single characteristic efficiency-capacity curve furnished this function for all pumps.

The critical cost function represented by the industrial power-rate schedules on which energy was purchased were represented by program subroutines capable of generating exact power costs. These contract subroutines contained the rate schedule itself plus such monthly adjustment features as power factor, historical power-demand value, and fuel-adjustment factors. Five contracts covered all energy purchased on the system.

The basic scheme of the simulation is a logical search procedure which develops all physically possible assignments of pumping units which will develop the required monthly throughput in the system. The search procedure finds all power levels at a given station which will develop a discharge pressure no greater than the line limit and produce a suction pressure at the



PLOTTED COMPUTER OUTPUT for an arbitrary pipeline. Fig. 9.

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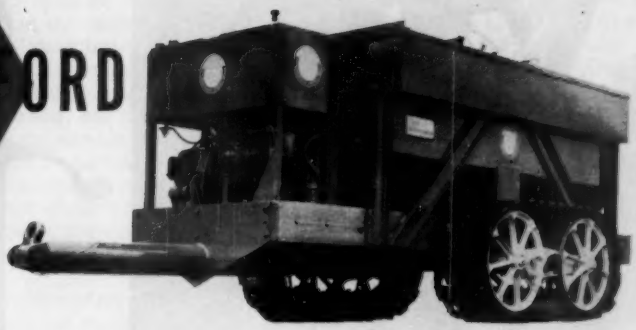

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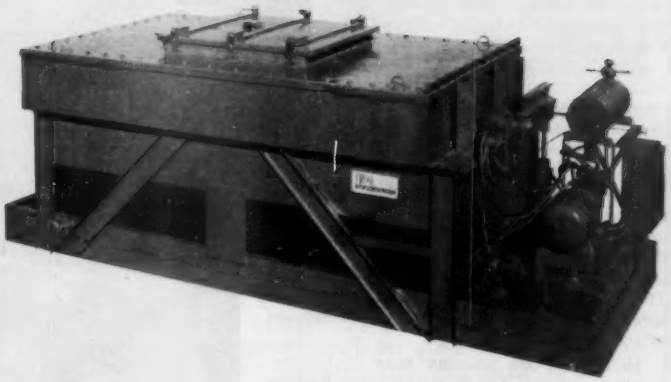

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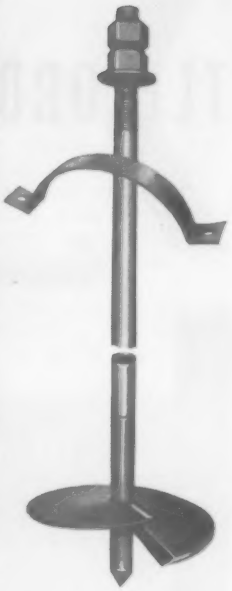

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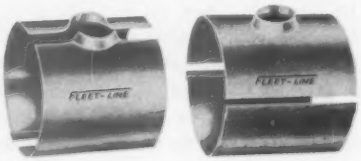

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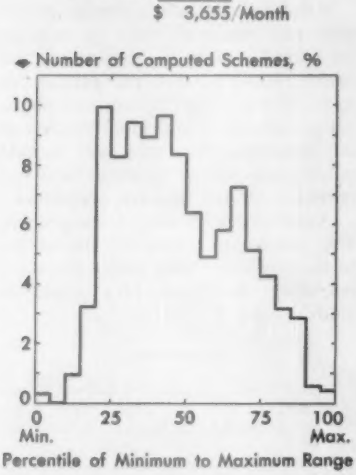

COMPUTED POWER COSTS for 240,000-bbl.-daily pipeline. Fig. 10.

next station downstream within the tolerance on that operating pressure.

The program output data consist of the power level (fully defining the combination of pumping units to be used) and operating pressures at each station combined in sets for the 10 stations; each such set of operating data constitutes a fully operable scheme for line operation at the given throughput rate, viscosity, and gravity.

The simulation of the line operation for a single throughput condition commonly develops between 500 and 1,000 feasible schemes; for each a different energy cost is found.

The operating data described above, containing power demand and energy use for each station, are then used to develop power costs for each of the stations for each of the previously computed operating schemes. A sum of energy costs for the system is made for each scheme and the lowest cost of all the schemes is identified and reported. In addition the output data contain all operating pressures and power levels at the 10 stations. These data then permit the operation of the line for the month at a minimum cost for the energy purchased.

The number of arithmetical operations for a typical simulation run is estimated at 8 million. The initial computer running time for the optimization was 20 hours. However, program modifications were eventually developed which disabled portions of the simulation; schemes which logic indicated could not possibly be improvements over previous schemes were thus bypassed. This program improvement eventually resulted in a reduction in computer running time to 2 hours.

(Current work on the problem of power cost optimization has shown that more efficient procedures exist for determining optimum line operating schemes than the method of "exhaustive search" described above. The application of a multistage allocation procedure, a method of dynamic mathematical programing, has been found to be a major improvement. Computer running time for a multistage allocation program designed for the same pipeline discussed above was found to be about 9 minutes, a major improvement over the previous requirement of 2 hours.)

Results: A test run of the simulation based on a projected throughput rate of 240,000 bbl. daily yielded 631 different feasible line operating schemes. Of these, the maximum system power cost for the month was $110,774. The optimum scheme had a power cost $3,655 less than the maximum. The distribution of the computed power costs associated with the 631 different operating schemes is shown in Fig. 10 in the form of a frequency distribution. The plot shows the percentage of the schemes which had costs in each 5% interval of the $3,655 range, minimum to maximum.

The cost-distribution plot suggests that an unskilled selection of an operating scheme would probably yield

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a cost of about $108,764. As the minimum cost available would be $107,119, the unnecessary cost incurred with such an unskilled scheme selection would be $1,650 for the month, or 1.5% of the total. The worst possible selection of an operating scheme, of course, would incur $3,655 of unnecessary cost for the month amounting to 3.4% of the total.

Conclusion

Current work. The simulation of oil pipelines is under active development by a number of companies. Recent literature reports work on scheduling, rough terrain hydraulics, and other phases of pipeline analysis.

Our own current work includes program development for line scheduling, tank-farm simulation using Monte Carlo methods, hydraulics recognizing individual batch properties, and the application of various mathematical programing methods to power optimization.

Ultimate objectives. In general, this new work is intended to bring the powerful new methods of modern mathematics and automatic computation into practical use in the management of pipeline operations. A working objective at this point of experience appears to be the ability to perform the following task:

Schedule, dispatch, optimize power cost, and minimize duty on tankage for a multistation, multiinjection, and multiterminal pipeline recognizing the hydraulics of rough terrain and physical properties of individual batches of oil. Schedules for lines will include batch compositions by crude field and permit a 90-day forward projection.

Associated with such a comprehensive simulation would be the ability to develop other data under projected operating conditions for economic study.

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Acknowledgment

As the work reported in this paper has been a group effort, credit for individual contributions should be stated as follows. All individuals are staff members of the technical services department of Shell Pipe Line Corp., Houston, Tex.

J. T. Jefferson, engineer, was responsible for the automatic-control simulation work in which he was assisted by R. D. Pfluger, engineer and principal developer of the power-level controller. Jefferson also developed the hydraulic simulation of a pipeline recognizing line profile. Mrs. Pat Tench, programer, assisted.

G. M. Clough, engineer, was responsible for the program work associated with two-phase flow design and power optimization. He was assisted by Mrs. Sara Coate, programer.

J. C. Gillett, engineer, was responsible for the work concerned with the operation of a heated oil line.

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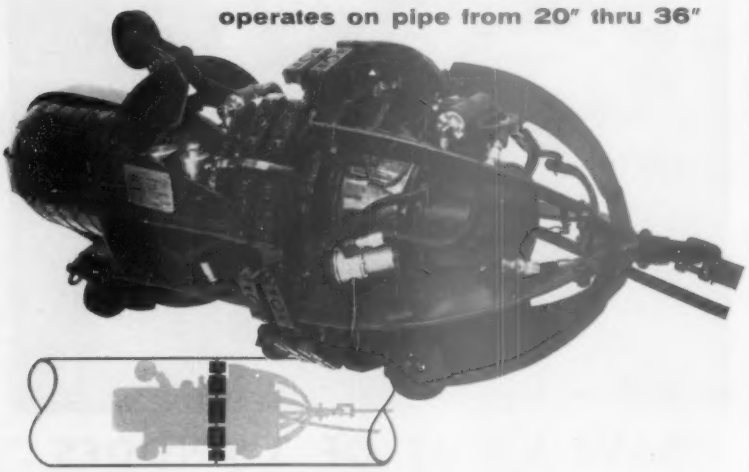

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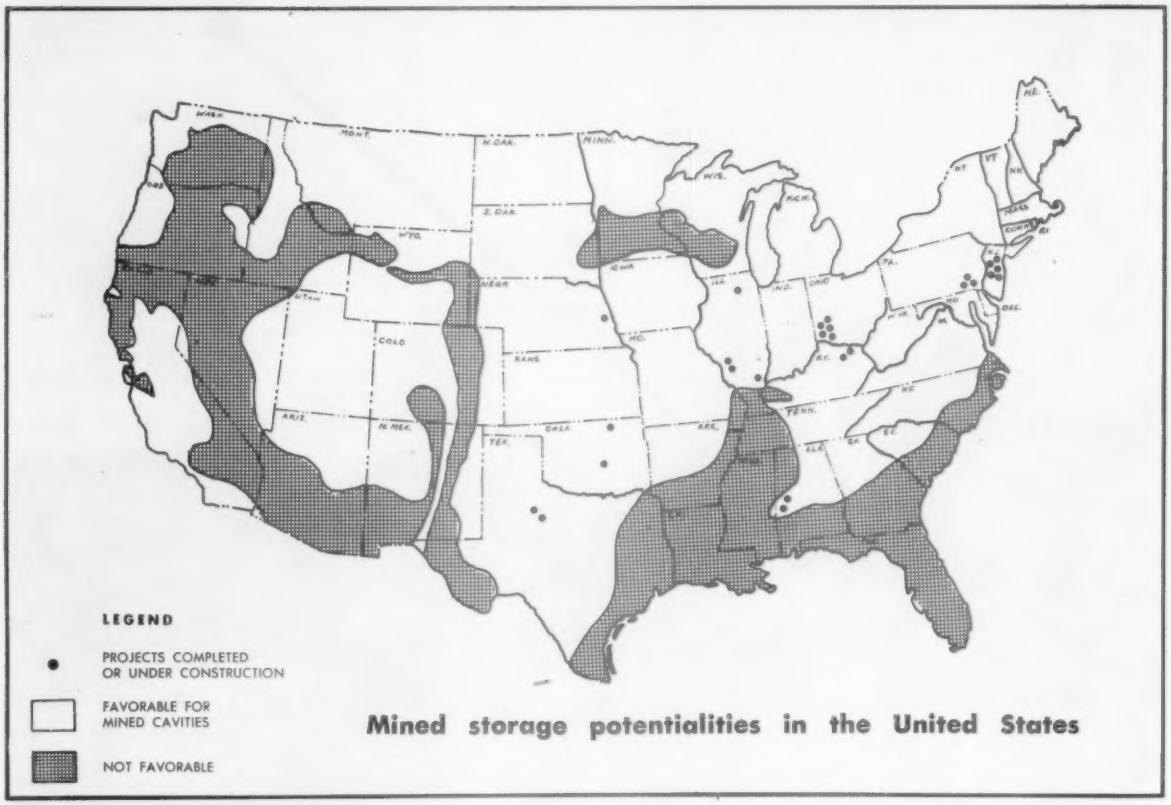

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CLIENT—LOCATION	CAPACITY BBLS.	YEAR COMPLETED	EARTH FORMATION
Warren Petroleum Corporation			
Breckenridge, Texas	20,000	1950	Shale
Breckenridge, Texas	30,000	1952	Shale
Aurora, Illinois	50,000	1953	Shale
Crossville, Illinois	50,000	1953	Shale
Sinclair Oil & Gas Company			
Seminole, Oklahoma	110,000	1954	Shale
Tuloma Gas Products Co. & Sinclair Oil & Gas Company			
Demopolis, Alabama	140,000	1956	Chalk
Demopolis, Alabama	225,000	1956	Chalk
Esso Standard Oil Company			
Linden, New Jersey	150,000	1957	Shale
Linden, New Jersey	150,000	1957	Shale
Linden, New Jersey	100,000	1958	Shale
Linden, New Jersey	125,000	1958	Shale
Linden, New Jersey	150,000	1959	Shale
Sun Oil Company			
Marcus Hook, Pa.	250,000	1958	Granite
Marcus Hook, Pa.	400,000	*	Granite
Marcus Hook, Pa.	250,000	1960	Granite
Columbia Hydrocarbon Corporation			
Siloam, Kentucky	210,000	1959	Shale
Siloam, Kentucky	85,000	1959	Shale
Texas Eastern Transmission Corporation			
Middletown, Ohio	160,000	1959	Shale
Middletown, Ohio	210,000	1959	Shale
Middletown, Ohio	135,000	1959	Shale
Middletown, Ohio	165,000	1959	Shale
Middletown, Ohio	200,000	1960	Shale
Shell Oil Company			
Wood River, Illinois	500,000	1960	Limestone
Wood River, Illinois	250,000	*	Limestone
Metropolitan Utilities District			
Omaha, Nebraska	150,000	1960	Shale
Continental Oil Company			
Ponca City, Oklahoma	300,000	*	Limestone
TOTAL	4,565,000		

*Presently under construction

Inquiries invited.

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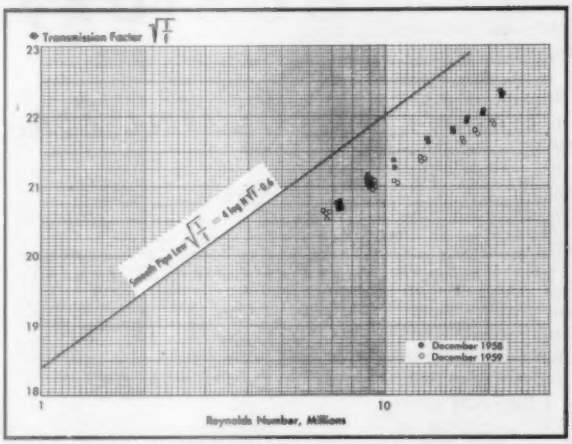
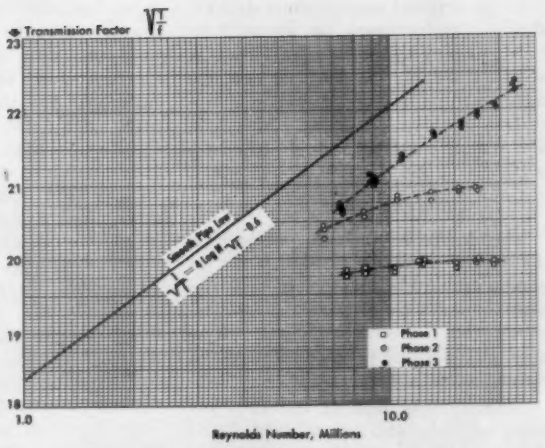


FLOW FERFORMANCE of 24-in. gas line with internal coating in December 1959 is compared with tests of same line after coating a year earlier. Fig. 1.



FLOW PERFORMANCE of same line is shown before cleaning (phase 1), after cleaning (phase 2), and after cleaning and internal coating (phase 3). Fig. 2.

Followup tests 1 year later by Tennessee Gas Pipeline Co. reproduced 1958 results within a very close tolerance of experimental error; there has been no apparent deterioration of the interior coating of the test section, which had flow increases of 5 to 10%, depending on rate of flow, after cleaning and coating.

Test shows internal coating boosts gas flow

BY C. H. KLOHN
Tennessee Gas Pipeline Co.

A series of flow tests was performed in December 1959 on an 11.896-mile section of 24-in. o.d. by .250-in. wall pipe, near Refugio, Tex. A range of flow rates was established, from 150 M.M.c.f.d. to 450 M.M.c.f.d., in increments of approximately 50 M.M.c.f.d.

These tests were a continuation of testing conducted in November and December of 1958. In phase 1 of the original tests the subject pipeline was tested in its existing condition after 10 years' operation; in phase 2 it was cleaned with two separately run wire-

TABLE 1—1959 TESTS—SUMMARY SHEET

Test	Date	Starting time	P_1 psia.	P_2 psia.	d_{po}	Qm M.M.c.f.d.	G	T_1 °F.	T_2 °F.	Average 1/z	f	Viscosity $M\times10^6$	$N_R\times10^{-3}$	$(1/f)^{1/2}$	Darcy coefficient f_o
1-A	12- 7-59	2.45	649.86	630.61	0.26	202.06	.597	68	67.5	1.0960	.002247	7.70	9,196	21.10	.008988
1-AR		4:35	646.23	625.90	.26	206.22	.595	68	67	1.0955	.002273	7.69	9,366	20.98	.009092
1-AR1		5:20	645.71	625.37	.26	206.30	.595	68	67	1.0955	.002270	7.69	9,370	20.99	.009080
1-B	12- 8-59	10:25	637.16	610.96	.25	234.41	.593	68	67.5	1.1007	.002249	7.67	10,638	21.09	.008995
1-BR		10:55	637.83	611.57	.25	234.87	.593	68	67	1.1022	.002251	7.67	10,659	21.08	.009006
1-C	12- 8-59	2:05	650.22	614.62	.26	278.93	.594	68	66.5	1.0948	.002178	7.68	12,663	21.43	.008713
1-CR		3:25	650.77	615.21	.26	278.72	.594	68	66.5	1.0948	.002181	7.69	12,637	21.41	.008724
1-CR1		3:50	651.63	615.90	.26	279.30	.594	68	66.5	1.0953	.002186	7.69	12,664	21.39	.008746
2-A	12- 9-59	1:25	699.35	641.75	.27	370.10	.596	68	66	1.1005	.002133	7.73	16,750	21.65	.008533
2-AR		2:00	700.14	642.49	.27	370.31	.596	68	66	1.1011	.002136	7.73	16,760	21.64	.008545
2-B	12- 9-59	3:55	708.30	640.66	.28	405.26	.596	68	65	1.1012	.002106	7.73	18,342	21.79	.008424
2-BR		4:20	709.17	641.33	.28	405.41	.596	68	65	1.1012	.002113	7.73	18,348	21.76	.008452
2-C	12-10-59	1:35	730.23	649.71	.28	450.29	.598	68	65	1.1057	.002080	7.75	20,395	21.93	.008321
2-CR		2:05	731.43	650.60	.28	450.62	.598	68	65	1.1057	.002088	7.75	20,410	21.88	.008354
3-A	12-11-59	10:25	687.49	677.25	.28	148.05	.600	68	65.5	1.1043	.002350	7.75	6,728	20.63	.009402
3-AR		10:50	687.02	676.86	.28	147.46	.600	68	65.5	1.1043	.002349	7.74	6,710	20.63	.009395
3-AR1		11:45	686.84	676.59	.28	148.02	.600	68	66.5	1.1043	.002351	7.74	6,735	20.62	.009405
3-AR2		12:10	687.12	676.72	.28	148.49	.600	68	66.5	1.1043	.002373	7.75	6,748	20.53	.009490

brush-type pigs, then tested; in phase 3 the section was cleaned, then coated with an epoxy coating, and tested after coating.

In the original tests pipeline deliverability was increased by about 5 to 10%, depending on rate of flow. A nearly constant 4% increase was directly attributable to the cleaning operation of phase 2 and an added 1 to 6% was directly attributable to cleaning and coating in phase 3.

1959 Test

The degree of stability obtained at the higher rates of flow was not as good as the 1958 tests. Pressure variations in most cases were 0.2 psi. between the 5-minute readings. However, the pipeline pressure differential remained fairly constant.

Stability was best at the two low rates of flow, and results reproduced those obtained in 1958. At the higher rates, however, both upstream and downstream pressures were consistently rising, which would tend to produce a lower-than-true transmission factor, since measurement facilities are downstream.

Fig. 1 shows the transmission factors computed for the 1958 and 1959 tests. (Fig. 2 gives the results of all three phases in the 1958 tests for comparison.) The 1959 tests are approximately 1% lower at the higher rates of flow. Part of this 1% may be attributed to the different degrees of stability attained.

1958 Tests

Experiments have shown that the resistance coefficient (f) is a function of Reynolds number (N_R) when the flow is laminar, or streamline. As the flow laminations are broken, a family of curves develops. These curves of the resistance coefficient are a function of Reynolds Number and the relative roughness of the pipe.

The relative roughness is a dimensionless ratio of interior surface roughness to pipe radius. The lower limit of the resistance coefficient is termed the "smooth pipe law."

As the degree of turbulence increases, the resistance coefficient departs from the smooth-pipe law and becomes a constant. It is then a function of relative roughness only. The family of constants is termed the "rough pipe law."

Experiments by Nikuradse laid much of the groundwork for present-day methods of analysis. However, Nikuradse created an artificial roughness of the interior by using uniformly screened grains of sand, and experimented with rather small pipe diameters and short distances. Colebrook attempted to describe mathematically the transition from the smooth-pipe law to the rough-pipe law.

The experiments of the Bureau of Mines have shown that the transition from "smooth" to "rough" is much sharper than the Colebrook equation indicates. But again, small pipe diameters and short distances were necessary for the Bureau of Mines tests. The question to be resolved by the Refugio tests, therefore, was: Does the condition of the internal pipe surface have much of an effect upon deliverability in a large-diameter pipe in commercial use?

This question is answered by an examination of Fig. 2. The total increase in the transmission factor, which is directly proportional to deliverability, varied from approximately 5% at a Reynolds number of 7,000,000 to about 10% at a Reynolds number of 18,000,000. As calculated by Tennessee Gas Pipeline engineers using Nikuradse's rough-pipe law, the roughness of phase 1 was 912 microinches and phase 2 was calculated at 520 microinches.

Phase 3 roughness could not be calculated since the transmission factor did not become constant, but the writer estimates (by continuation of phase 3 curve) something less than 180 microinches. Northern Natural Gas Co. engineers obtained average roughness of 952 microinches for phase 1, 573 microinches for phase 2, and 413 microinches for phase 3.

Smooth-pipe law. Close examination of Fig. 2 reveals that the tests indicate a smooth-pipe law evolving a transmission factor about 4% less than that of Von Karman. There are several reasons for this apparent discrepancy. In order of importance, they are:

1. The characteristics of commercial use. The work of the Bureau of Mines was a valuable addition to the knowledge of flow characteristics. It showed that small amounts of liquid or solid material in the pipeline had considerable effect upon deliverability. The bureau filtered all of the gas in verifying Von Karman's equation for smooth pipe.

Although the gas used in testing the 24-in. line was dehydrated, and a large portion was processed by gasoline plants, it is believed there still was sufficient foreign material present to appreciably affect the transmission factor. Any unfiltered stream should produce similar results.

2. Bends. Another factor contributing to the discrepancy was the 79 wrinkle bends in the test section. The bends would add some resistance to flow, leading to an error. One way of correcting this error is to use "equivalent" length, rather than actual

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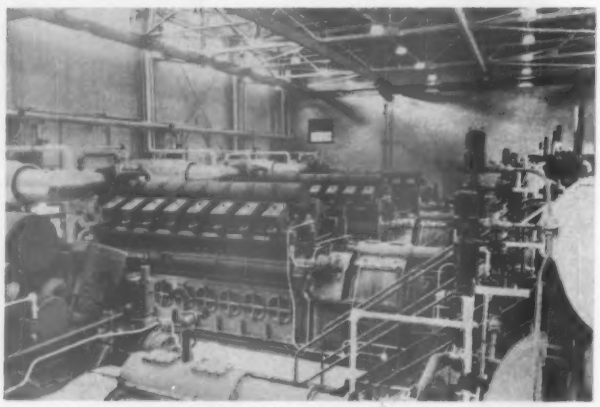

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length. To obtain agreement between the phase 3 tests and the Von Karman smooth-pipe law would call for allowing 63 ft. of added pipe per bend, or 23 ft. more pipe per wrinkle. The writer believes this is far too much to allow, since the wrinkle is a depression of the interior, rather than an intrusion into the interior.

3. Different roughness. The total length of the test section (between pressure-measurement stations) was 62,812.5 ft. Of this, 147.7 ft. was not cleaned in phase 2 or coated in phase 3. Operations were started 65.9 ft. downstream of the upstream tap, and completed 81.8 ft. upstream of the downstream tap. Thus, the test section presented two different surfaces to the stream. Since this is only 0.23% of the total length, it was not considered important.

4. Possible error in viscosity. Viscosity was calculated, not measured. However, a fairly large error is necessary to shift the plots to the right or left appreciably.

5. Reduction in diameter. A calculation of the gallons of coating used shows an average 6-mil thickness. This reduction of diameter theoretically will affect the transmission factor by slightly more than 0.1%.

Practical Smooth-Pipe Law

The smooth pipe law of Von Karman and the Bureau of Mines states:

$$1/(f)^{1/2} = 4 \log N_R (f)^{1/2} - 0.6 \quad (1)$$

For practical application, the effect of bends and foreign materials may be taken into account by writing a "practical" smooth-pipe law. For extremely smooth pipe in commercial use, the resistance coefficient of Equation 1 can be assumed from the results to be approximately 92% of the actual resistance coefficient. Thus, a practical smooth-pipe law:

$$1/(f)^{1/2} = 4 \log N_R (0.92f)^{1/2} - 0.6 \quad (2)$$

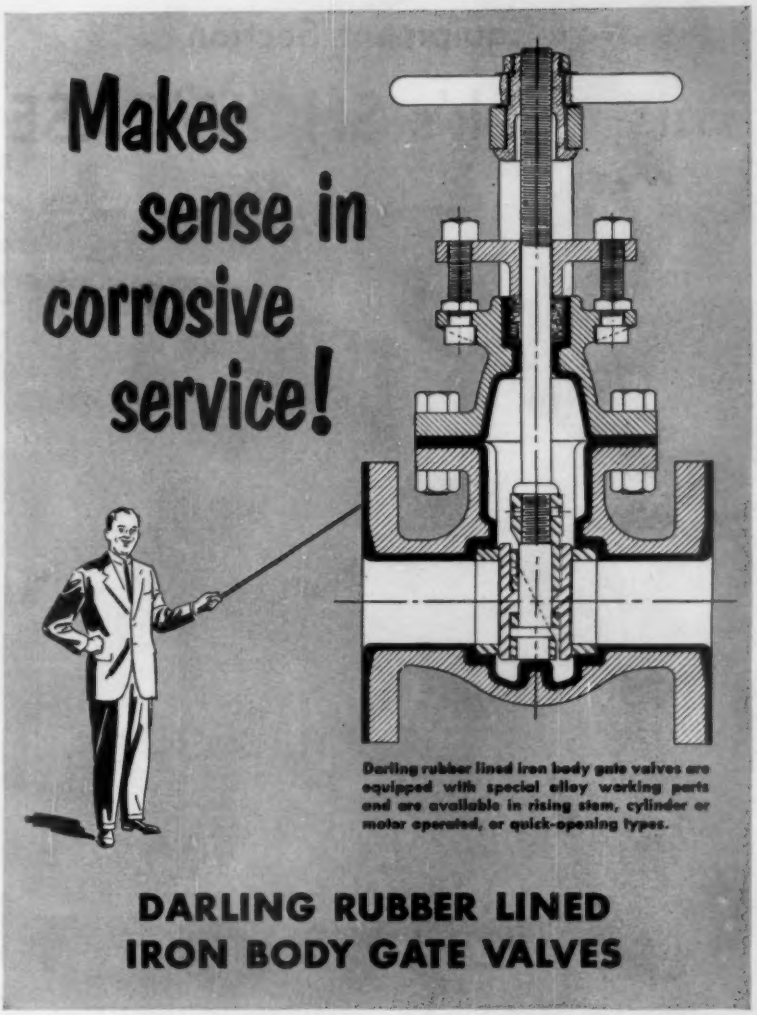
which reduces to:

$$1/(f)^{1/2} = 3.84 \log N_R (f)^{1/2} - 0.5 \quad (3)$$

The author suggests that this equation could be used for estimating purposes with more accuracy than Equation 1.

Acknowledgment

Tests reported here are part of a joint project conducted under the auspices of Tennessee Gas Pipeline Co., Texas Gas Transmission Corp., Lone Star Gas Co., Transcontinental Gas Pipe Line Corp., Humble Oil & Refining Co., El Paso Natural Gas Co., Trunkline Gas Co., Northern Natural Gas Co., Coast Paint & Lacquer Co., and Pipecote Service Corp.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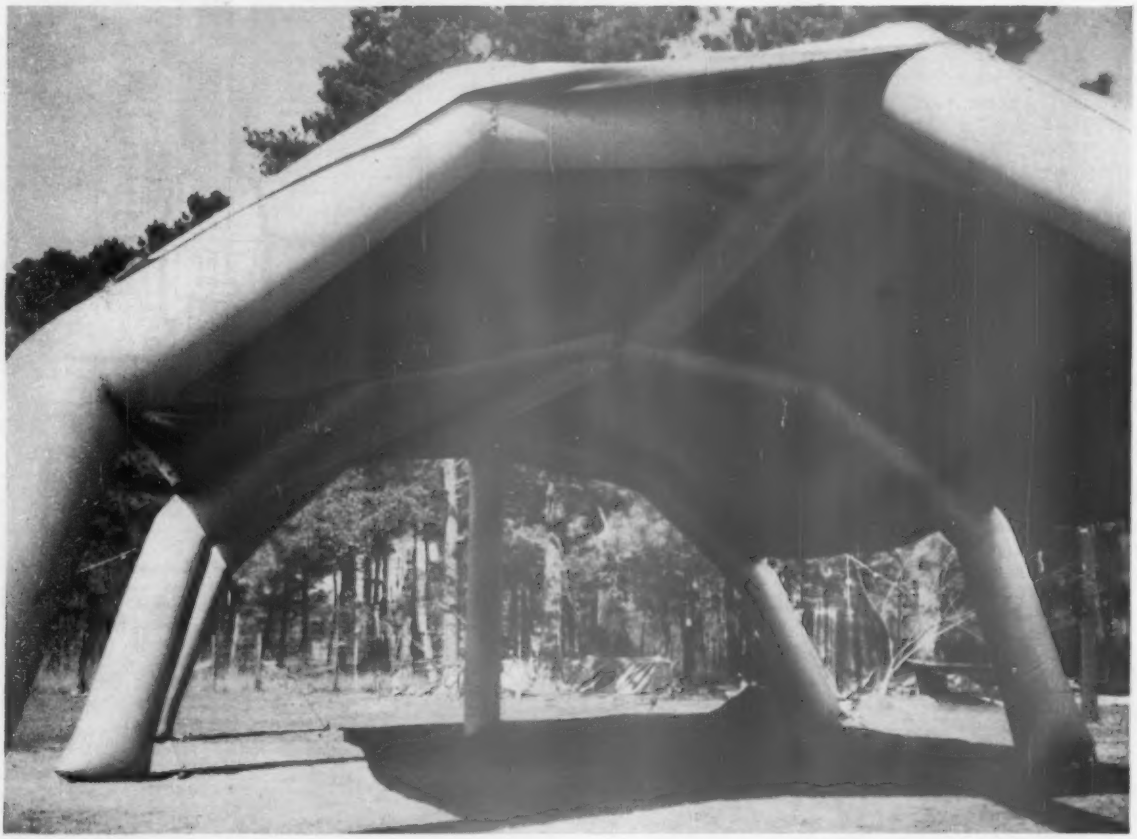

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To erect the structure, just inflate the air columns and provide proper anchoring. According to the manufacturer, typical erection time is one man-hour per 1,000 sq. ft. of area covered. After erection, the structure can be moved easily. Delivery: 1 to 2 weeks. Approximate net price, f.o.b. factory: from $1 to $2 per sq. ft. of ground covered. Source: **Air Structures, Inc., Box 8217, Shreveport, La.**

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WHAT MAKES A good waterflood Packer?

Waterflood service demands a packer that's long on performance and short on cost. The picture shows one that is. It is lean and clean, short and compact. Its packoff is positive and dependable, it has great holding power, it is easy to set and retrieve. What makes all these things possible in a low cost packer? See the facts below.

BAKER

Model A Retrievable Tension Packer

To get Bulletin 334, write Baker Oil Tools, Inc., P.O. Box 2274, Terminal Annex, Los Angeles 54, Calif.

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A quick look at the facts about this important retrievable pressuring tool

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WHERE AND HOW TO USE IT

1 It gets its main play in waterflooding.

2 It's also a squeeze packer for simple pressuring operations where you don't need the supervision of a Baker tool specialist. For instance: when fracturing in shallow or low-fluid-level wells.

3 There are times when you may want to leave a packer in the well after a pressuring operation. The low cost of a Baker Model A recommends it for such service.

4 There are also times when you may *have* to leave a packer in the well. For instance, when you've got defective casing and there's doubt you would be able to retrieve *any* packer. You can leave one of these low cost packers in the well and knock it down out of the way with little trouble or expense.

5 You can set and reset any number of times in one trip. It is rugged enough to be used many times in many wells.

6 It is simple to maintain and redress. Standard parts are available from Baker's many field service locations.

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A simple and reliable J-Slot makes this packer very easy to set and release.

1 To set packer, you rotate tubing ¼ turn to left to unjay the slips, then apply tension to pack off.

2 To release, you relax tubing tension to relax packing element and permit slips to retract, then rotate ¼ turn to right to lock them in retracted position. Now you can retrieve.

3 There are two safety release systems.

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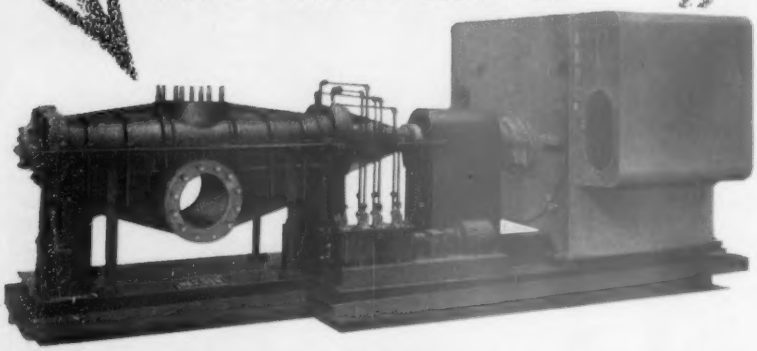

the WARREN HIGH PRESSURE SCREW PUMP

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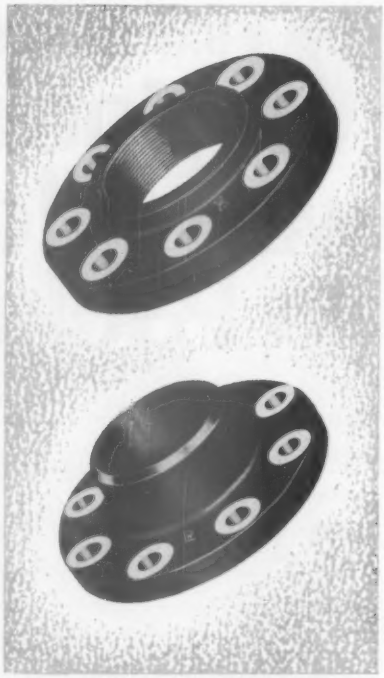

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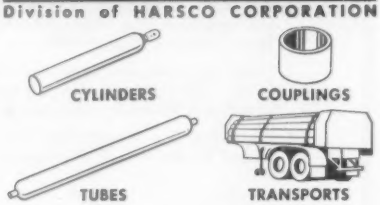

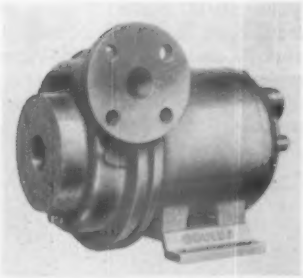

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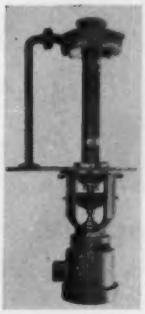
. . . promised with the Fig. 3900 sealless canned centrifugal pump now being produced to handle volatile, toxic, flammable, or other hazardous fluids. Made in two sizes with 1 and 1¼-in. discharge, the pump has a capacity range up to 110 g.p.m. and heads up to 100 ft.

The maker recommends it for handling clear liquids only. A portion of the pumped liquid is circulated to cool and lubricate pump parts. A built-in thermal cutout device protects the motor against high temperature. The pump is regularly supplied in Type 316 stainless steel. But other materials are available. Price ranges from about $575 for a 1-in. size with ⅓-hp. motor to $610 for 1¼-in. size with ½-hp. motor. Source: **Goulds Pumps, Inc., 203 Black Brook Road, Seneca Falls, N. Y.**



Centrifugal pump

. . . for chemical process service comes in 14 sizes from 5 to 500 g.p.m. at heads from 10 to 120 ft. and settings from 3 to 16 ft., inside or outside tank-mounted. The vertical Type pHV pump comes in 17 alloys to meet most corrosive acid and caustic applications in a temperature range from —300° to 750° F. Price ranges from about $470 for 5 g.p.m. to $705 for 500 g.p.m. capacity. Source: **Dean Brothers Pumps, Inc., 323 West Tenth, Indianapolis.**

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Hooking a Sauder Type T Pressure Treater into your line gives you: 1, an Oil and Gas Separator. 2, a Free-Water Knockout. 3, a Preheater. 4, a Pressure Emulsion Treater — ALL IN ONE! — And adjusting the water level is no longer a shutdown problem! Sauder's quick water level adjusting control adjusts in minutes . . . without taking treater out of service! Backed by 35 years of specialized oil field service!

type T treater

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Gotkool water cans and coolers

Specify **"GOTKOOL"** the next time you order water cans or coolers. **"GOTKOOL'S"** exclusive construction keeps water cooler . . . fresher . . . purer. Extra wide, snug-fitting, splash-proof top keeps out impurities. Non-leaking, push-button faucets, either extended or recessed flush-mounted. *Buy* **"GOTKOOL"** *at your supply store today.*

GOTKOOL *Water Cooler* — made in 1½-, 2-, 3-, 5-, 10-, 15-, and 20-gallon sizes with either extended or recessed, flush-mounted faucet.

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The First Accurate PRESSURE GAUGE! For Applications Requiring . . . RUGGEDNESS and DEPENDABILITY

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Metric Equivalents Available.

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Write for Bulletin No. P-85
MARTIN-DECKER CORPORATION
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Long Beach 7, California

World's Principal Manufacturer of Oil Well Drilling Instrumentation

Solution to subsurface drainage

. . . of plant sites and other locations is offered by a new perforated asbestos - cement pipe. Called Transite Underdrain pipe, it is formed basically of asbestos fibers and cement. According to the maker, it has a dense uniform structure that gives it great crushing strength. Its interior is smooth and uniform.

A tight but flexible joint is obtained through the use of mechanically exact plastic couplings. The pipe comes in 6 and 8-in. diameters in 10-ft. lengths and 10 and 12-in. diameters in 13-ft. lengths. A variety of fittings are available in each size. Source: **Johns - Manville, 22 East Fortieth Street, New York 16.**

X-ray unit for outdoor use

. . . just disclosed is a portable type that, the maker claims, provides high penetrating power and excellent radiographic definition. Completely self-contained, it is shockproofed, rayproofed, and weatherproofed, the maker says. Safety devices effectively prevent overload on the tube. Since it weighs only 231 lb., the tube head can be hoisted to remote areas for radiography of more than 3 in. of steel.

The X-ray voltage is continuously adjustable under load in a stepless range from 65 to 300 kv. Power required for the Model PG 300 unit is 220 volts, 50/60 cycles, 9 amp. An automatic reset timer is included with the control unit. Delivery: 45 days. Approximate list price, f.o.b. factory: $6,300. Source: **Philips Electronic Instruments, 750 South Fulton Avenue, Mount Vernon, N. Y.**

Combination mud-air rotary drill

. . . soon to be available is designed to handle seismograph, exploration, and shallow-well drilling. While designed to be small and compact, the truck-mounted drill is ruggedly built. It has a split-type of power takeoff with individual friction clutch drives for all main machinery, a double-drum draw works, spiral bevel gear rotary table with four-speed forward and reverse drive, and a sturdy pipe-storage rack.

A continuous type of chain pull-down, powered through a dual-range hydraulic system, affords infinitely variable control over bit pressure. Constructed of square tubing, the steel mast is hydraulically raised and lowered and can be used with 15-ft. long drill pipe. Optional is a 5-ft. mast extension to handle 20-ft. pipe.

The self-adjusting, built-in breakout wrench accommodates tool joints with o.d. of 3 to 4⅛ in. Cuttings are removed either by air or mud. A single-stage compressor rated at 485 c.f.m. supplies air for drilling. A 5 by 6 mud pump is available. Both the compressor and pump are V-belt driven from the power takeoff unit. Delivery: 60 days. Approximate list price, f.o.b. factory: from $20,675 for machine for mud drilling mounted on a truck, to $26,925 for machine for mud and air drilling mounted on a truck. Source: **Bucyrus-Erie Co., Richmond, Ind.**

Want more facts about equipment or copies of product literature described in this issue?

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How a "Wedding Band"...

gives double strength to

AMERICAN IRON

Flash Welded Tool Joints!

An induction coil or "Wedding Band" is a new strengthening process used by American Iron for heat treating their Flash Welded tool joints at the weld line.

The induction coil heats the weld line and the heat affected areas from flash welding, to approximately 1700 degrees in a very short time.

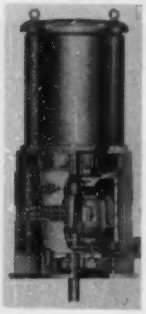
This process improves the physical properties of the material by refining the grain size which has been enlarged during the weld cycle. It causes a "wedding" of the grain structures across the weld interface. There is no longer a weld line . . . but now a ductile, strong weld zone.

The entire heat-treating process more than doubles the tensile-impact strength of the Flash Welded connection. This is just one of the many exacting processes and tests used at American Iron in the manufacture of tool joint-to-pipe connections. Another reason why you buy QUALITY when you specify AMERICAN IRON.

Specify Flash Welded OPEN-HOLE *Tool Joints for your Lightweight Drill Pipe*

AVAILABLE THROUGH YOUR SUPPLY STORE

Magnetic pump drive



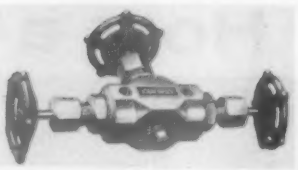
. . . now sold, the Ampli-Speed, comes in five sizes to provide variable pumping speeds from 0 to 1,740 r.p.m. A built-in speed-control circuit holds the preset vertical drive speed to within ±2%. The drive is air-cooled. The eddy-current slip device uses two rotating members which slip with respect to each other. The control is all transistorized and mounted in its own cubicle. Price ranges from about $1,200 for a 3-hp. to $2,500 for a 310-hp. unit. Source: **Electric Machinery Mfg. Co., Minneapolis.**

●

Instrument connections

. . . simplified with an instrument-valve manifold now being marketed. The Yarway manifold can be used to make instrument connections to flowmeters, level indicators, and other instruments.

It combines three valves in one body. Two provide line shutoff. One



equalizes pressures to protect instruments' internal working parts. A connection tap provides for calibration of the high-pressure side of the system. End connections can be either screwed or socket-weld. The body and working parts are stainless steel. Approximate net price, f.o.b. factory: $49.75. Source: **Yarnall-Waring Co., Chestnut Hill, Philadelphia 18.**

●

Steam trap

. . . installation is faster with a new model now on the market. It has a union incorporated into it to reduce both the initial cost of trap installation as well as maintenance. Designed into the trap inlet, the union eliminates the time involved in fitting pipe to a union.

The built-in feature is optional at slight extra cost on Quik-Flex thermostatic steam traps in the ½ and ¾-in. sizes. Delivery: immediate. Approximate price, f.o.b. factory: from $18.50 to $44.00. Source: **V. D. Anderson Co., 1935 West Ninety-sixth, Cleveland 2.**

●

Safer hoisting

. . . is promised by the new RA series of ratchet and pawl aluminum lever hoists that come in six models with rated capacities from ¾ to 6 tons. The hoists have low head room and a standard lift of 5 ft. For safety, a double pawl arrangement is designed so one pawl is always engaged with the ratchet during lowering or lifting. A safety handle bends to indicate overloads and to avoid chain or hook failures. The handle will not ratchet if load is released unintentionally. Price ranges from about $64.50 for ¾-ton to $221.50 for 6-ton capacity. Source: **Coffing Hoist Div. of Duff-Norton Co., Danville, Ill.**

Pipe Line Technologists, Inc. provides specialized professional engineering for every phase of oil, gas, chemical and products pipe line operation, from the initial market analysis and feasibility reports to the design, engineering, financial planning, supervision of construction and management of the completed project. The findings of these experienced, qualified, specialists in their field are coordinated by group action into conclusive reports and efficiently built and operated pipe lines.

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This is the main reason more and more Corrosion Engineers are specifying Nicolet Asbestos Pipe Line Felts with complete confidence. Whether they need Nicolet #15 "Standard", #8 "Tufbestos" or #10 "Reflecto" (the new, improved, white Asbestos Felt) they know they will be providing the best possible pipe line protection.

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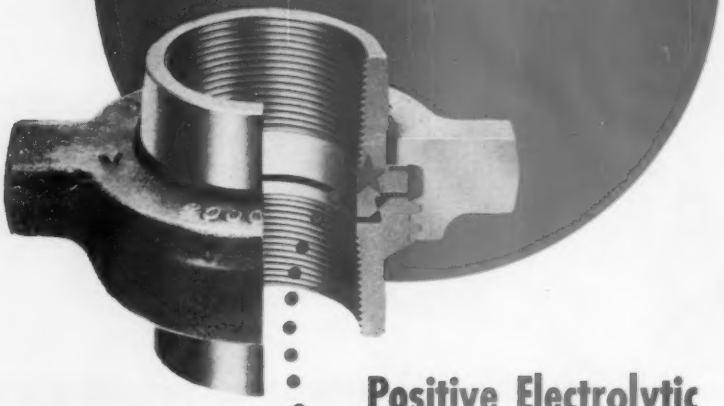

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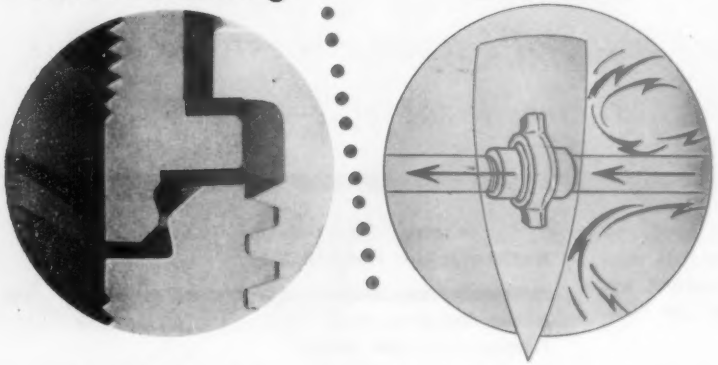

Now, stop electrolytic action on pipes and fittings with new WECO Fig. 211 Insulated Unions. Special locked-on, laminated insulating rings provide more than 35 million ohms resistance across the union. Full circle contact seating of an "O" ring seal ring provides perfect sealing at pressures up to 2000 psi and at temperatures up to 350° F.

Stocked by supply stores everywhere . . . ready to give you perfect electrolysis control wherever unions are used. Sizes 1" through 4".

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SHOWCASE . . .

New Literature

Gages and Instruments

. . . for the Process Industries is the title of new 4-page Bulletin 3015, expected to simplify your job of choosing the right gage or instrument by providing a roundup of products. The bulletin features pressure and vacuum gages, indicating pneumatic controllers, and pneumatic transmitters.

A schematic shows the installation of an indicating pneumatic controller in a typical cascade control system. The publication includes construction details and technical data. Photographs illustrate range and linearity adjustment and pointer adjustments.

Tables list tube forms and materials, socket and tip materials, pressure ratings, flange types, and figure numbers for ordering purposes. Source: **U. S. Gauge Div., American Machine & Metals, Inc., Sellersville, Pa.**

Fire protection is offered

. . . by the installation of water curtains and surface-flooding units, according to a new 6-page pamphlet just issued by a British firm. The water-curtain system, when applied to workshops, provides a shield of water, thus doing away with radiation and flying sparks. The surface-flooding system quenches fire by flooding or by providing a cooling effect by evaporation. The literature gives installation data, general arrangements, and nozzle specifications. Source: **Ascog, Ltd., Ascog House, 44 Theobalds Road, London, W.C.1., England.**

Attapulgite-products bulletin

. . . recently published, gives an account of the history of attapulgite, along with the product's natural and processed properties. Photographs show actual production. The literature includes applications (drilling and refining), specifications, typical screen analysis, and information on the company's laboratory assistance. Source: **Magnet Cove Barium Corp., P. O. Box 6504, Houston 5.**

Nozzle

. . . provides uniform distribution of large quantities of liquids under low pressure, as described in a new eight-page pamphlet. Application possibili-

ties cited for the Hesky-System nozzle include: absorption, rectifying, and distillation columns; saturator; dehumidifier; washing and cooling towers (with or without inserts); and coke-quenching plants. The literature contains data on construction, pressures, characteristics, installation, capacities, and weights. Source: **Ascog, Ltd., Ascog House, 44 Theobalds Road, London, W.C.1, England.**

Tubing-anchor

. . . brochure deals with a new hydraulically actuated compensating frictional tubing anchor. The four-page publication, available now upon request, presents advantages, construction features, specifications, and a cross-sectional drawing. Source: **McGaffey-Taylor Corp., 2877 Cherry Avenue, Long Beach, Calif.**

Screen pipe

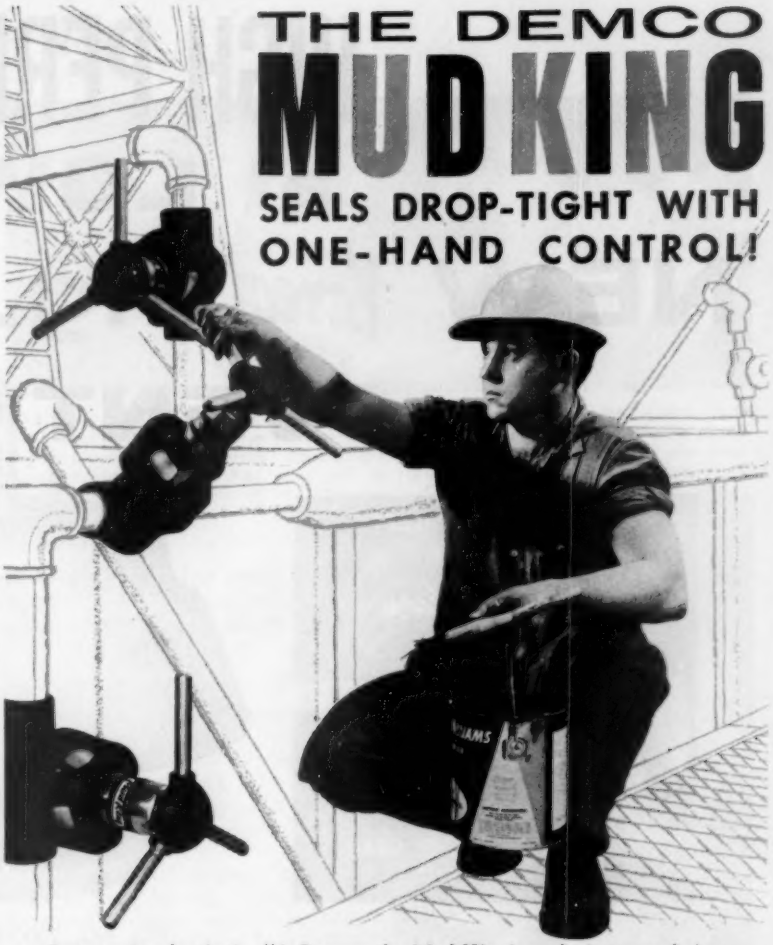
. . . for oil, gas and water wells is described in a new 8-page catalog, obtainable now upon request. The publication details the "More Area" slotted-screen pipe, vertical slotted, and drilled-hole wire-wrapped screen, ribbed-type wire-wrapped screen, and prepacked gravel-pack screen, together with specifications of the various types. Source: **Emsco Screen Pipe Co., P. O. Box 14446, Houston 21.**

Controlled-capacity

. . . Catalog 200, just published, provides detailed information on Series 200 controlled-capacity chemical-feed pumps. It includes data on the design and construction of simplex and duplex models. With a repetitive metering accuracy of ±1%, the pumps are designed to move specific volumes of fluid into high and low-pressure systems. Source: **Pump Div., American Meter Co., 13500 Philmont Avenue, Philadelphia 16.**

Hydrocarbon-recovery

. . . units (short-cycle adsorption types) for moderate-pressure gas systems are the subject of a new brochure recently published. The eight-page literature piece explains the Dry Frac process in detail, and displays two, three, and four-tower systems—with both open and closed-cycle regeneration—by using informative diagrams. A BS&B 4-tower Dry Frac unit was the first of its kind to be put into operation. It was placed onstream in a Texas field several months ago. Source: **Black, Sivalls & Bryson, Inc., 7500 East Twelfth, Kansas City 26, Mo.**



THE DEMCO
MUD KING
SEALS DROP-TIGHT WITH ONE-HAND CONTROL!

Just one hand—that's all! Because the Mud King's exclusive spread-ring seat construction gives a positive seal against the highest line pressures *—without applying undue torque to the valve!*

And you get much more! Body remains in line while entire inner assembly lifts out for easier, faster inspection. Fewer parts are subject to wear. Self-lubricated stem threads are protected from abrasives by *double* stem seal.

Countless field applications have proved the Mud King to be equally effective in water flood, well-head, hydra-frac, acidizing and cementing services.

Add up DEMCO's *Plus Factors* and you'll agree—the Mud King will bring efficiency and economy to your operation, too!

AT SUPPLY STORES EVERYWHERE!
In 2,000, 3,000 and 5,000 Lbs. W. P.

DRILLING EQUIPMENT MANUFACTURING CO.

845 S. E. 29th Street • OKLAHOMA CITY, OKLA.

HIGH PERFORMANCE at LOW COST

NEW "Varec" Fig. 2000 SERIES VENT VALVE

FIG. NO. 2000-81 PRESSURE-VACUUM VENT VALVE

"Varec" has a new Vent Valve with a feature that is going to make contemporary vent valves outdated! It's the unique new "Air Cushion" insert in the pallets.*

The "Air Cushion" forms a perfect air-tight seal with the anodized seat ring. Anodizing prevents corrosion. The insert is made of a special compound of synthetic rubber, which resists freezing. It is flexible yet durable, providing long service with minimum maintenance. Inserts are easily replaced.

A 20% cut in weight makes this new "Varec" Vent safe for mounting on lightest gauge tanks. Installation is made easier and in many cases special rigging is unnecessary.

Increased flow capacity has been developed by a new flared, sturdy, spun-type aluminum hood.

"Blow down" is scientifically controlled, insuring greater vapor conservation than diaphragm type valves.

This "Varec" Fig. 2000 Series Vent Valve incorporates all the latest improvements and refinements in design, yet with all its quality, efficiency and low maintenance expense . . . it costs you less. It will pay you to get full details . . . ask for Catalog Page 2-0.1.

*Pliable solid type rubber inserts only in 2", 3", 4" sizes and high pressure settings.

"Varec"
TRADE ® MARK
JAPAN NO. 539648

THE VAPOR RECOVERY SYSTEMS COMPANY

P-8

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▶ ▶ ▶ Equipment Men Notes

Rolo Mfg. Co. considers

R. K. Franklin

. . . overseas expansion through the formation of European subsidiaries and the construction of one or more European manufacturing facilities, reports President Robert K. Franklin. Franklin is now in Europe for an on-the-spot appraisal of the foreign market for the Houston firm's oil-metering equipment, which is currently in use in 30 countries. Rolo's president will join the company's chief engineer, R. G. Oliphant, for part of a Europe, Africa, and Middle East tour.

AXELSON SCHOOL dealing with hydraulics, engineering, and application, was held recently in Los Angeles. The meeting covered all phases of hydraulic-pumping-unit design, engineering, application, and calculations. Shown at the Axelson hydraulic test facilities are: (left to right) Tom Laney, Hugh Wiles, H. F. Donley, Bill Powell, Dick White, John Black, Charles Haughland, Charles Welch, and F. J. Graham.

Walter J. (Walt) Blair is named

. . . vertical-pump-product sales manager, Peerless Pump, Hydrodynamics Division, of Food Machinery & Chemical Corp. Blair first joined Peerless in 1949. He has served as a sales engineer in the Los Angeles area and, for the past several years, has been product sales manager of the organization's process line of pumps.

Elder Trailer & Body, Inc. buys

. . . a new manufacturing plant in Houston. According to Forrest McGrath, Elder president, most of the company's trailers for industrial use will be manufactured there. Another part of the Houston operation will include installation of truck equipment.

National Supply Co. transfers

. . . Russell J. Wisecup, supervisor of rotary-equipment sales in Venezuela, to the company's export-division headquarters in New York City as division engineer—drilling. Galen L. Lindner will continue as division engineer—production.

Wisecup joined National Supply in 1951 at Rock Springs, Wyo. He was promoted to sales engineer in 1953 with service at Williston, N. D., Billings, Mont., and Casper, Wyo. He also served as sales-office supervisor in the northwest division office at Denver. Wisecup was transferred to National Supply Co. of Venezuela, C.A. 3 years ago.

Hugh Q. Buck is named chairman

. . . of the board of Houston Oil Field Material Co., Inc. at the company's recent annual shareholders meeting. The company also announced that J. T. Kenneally, who had been serving as executive vice president, has been named president. Frederick W. Rich-

H. Q. Buck

J. T. Kenneally

mond was named chairman of the executive committee.

Other officers elected were: Z. C. Ambrose, executive vice president; C. L. Roach, vice president, domestic operations; A. W. Waddill, vice president, public relations; George E. Justice, vice president, manufacturing; H. T. Hamm, secretary-treasurer, controller; James H. Kerr, Jr., assistant secretary; Lawrence S. Bangser, assistant secretary; M. H. Albert, assistant secretary; and Grace G. Scown, assistant treasurer.

WORLD'S LARGEST oil-field pumping truck for fracturing uses has been completed by Stewart & Stevenson Services, Inc. and put into operation in West Texas by Western Co. The truck, which has a horsepower rating of 1,340, complements a record-volume sand-fracturing blender which previously joined the Western fleet and which also was designed and manufactured by Stewart & Stevenson.

Oil Well Supply lists changes

. . . within the division's central midwest, eastern, and its California areas. Two new Texas store managers have been named: Leonard W. Burk, at Graham, and Vernon D. Taylor, at Gainesville. Glen L. Hillis will join Taylor as Oilwell's new field representative at Gainesville.

Edwin D. Estes, a 12-year division member, takes over as field representative at Mattoon, Ill. He will

move from Carmi, Ill., where he held the same position. In California, Harold E. Shuck assumes a field-representative post at Taft, and Bobby D. Graham takes on the same job at Bakersfield.

Lone Star Steel reveals plans

. . . for the purchase of millions of tons of iron ore located in the South Basin of Texas, and the possible construction of one or more smaller steel mills near the South Basin deposits. The program, already under way in four East Texas counties, may be expanded if the ore bodies so indicate.

Roy W. Johnson is appointed

. . . manager of contract sales for Keenan Pipe & Supply Co. He will headquarter at Keenan's main plant in Los Angeles.

Johnson was employed by Republic Supply Co. as warehouseman in 1934, then was successively in field stores, branch manager, and vice president in charge of the northern division in San Francisco. For the next 2 years he was vice president in charge of sales in Los Angeles. From 1952 through 1957 he was executive vice president. For the past 2 years, Johnson was vice president of Culbert Pipe & Fittings Co. in Jersey City, N. J.

Happy Co. names A. M. Cuellar

. . . as manager of the newly opened Houston sales office. Cuellar began his business career in 1948 with Gasoline Plant Construction as process design and project engineer, and then spent several years with American Republics Co. as assistant manager of plants.

In 1955 he became chief process engineer with Tellepsen Petro Chemical Construction and then spent a brief period with Nutter Engineering as design engineer. After a period of time operating his own company, he was associated with Pona Engineering.

Regional sales managers named

. . . for Delta Tank Mfg. Co.'s Oilfield Equipment Division. J. T. Roberts, Jr. assumes responsibility for the east-

J. T. Roberts

E. G. Murphy

ern region, and E. G. (Spud) Murphy for the western.

Roberts will direct the company's oil-field sales activities in Louisiana, Mississippi, and Alabama from his headquarters in Lafayette, La. Prior to joining Delta about 4 months ago, Roberts had served in a managerial capacity with other petroleum-equipment manufacturers for some 16 years.

Murphy will direct Delta's direct sales and service activities in the Mid-Continent and Rocky Mountain areas from his Houston headquarters. A manager for several manufacturers, he has also been an independent operator during his 35 years in the business.

Noel D. Morris named manager

. . . of the new Well Drilling Machinery Div. at Alten Foundry & Machine Works, Inc., Lancaster, Ohio. The appointment was announced by Warren Benson, vice president. Morris was

Watch . . .

WILLIAMS BROTHERS

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Washington — Pittsburgh — Louisville
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Bogota — La Paz — Edmonton
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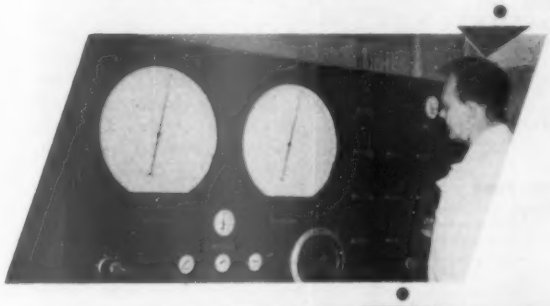
What are the things you expect everytime you specify *Halliburton* for your fracturing operation? An experienced crew working with the most modern fracturing equipment ... the latest fracturing materials ... the *best* from a wide selection of fracturing techniques to help obtain a successful job. You may be familiar with these ... but what about the wealth of experience, facilities and activity of the research men who make up the Halliburton team behind the fracturing crew? These advantages are yours, too ... when you specify Halliburton:

CHEMICAL R & D LABORATORIES ... the most complete of any oil field service company in the world. Here, skilled research chemists and engineers seek answers to problems such as – "The best cementing practice for improving formation fracturing" ... "The most applicable fluids for a formation." A constant research program is maintained for developing new and improved fracturing fluids, additives and techniques. They also search out information for you by making chemical and physical analysis of cores and cuttings ... utilizing X-ray diffraction and other techniques.



M R D (Mechanical Research and Development) ... Here, millions of dollars and thousands of man hours are invested in improving current fracturing equipment ... and developing completely new ideas to do a job better – faster – more economically than ever before.

EQUIPMENT DESIGN / TOOL DESIGN

... Here, complex equipment is engineered to meet specific field requirements. One section is constantly improving fracturing equipment efficiency and developing new equipment ideas. The other section designs special tools and other down-hole equipment to help obtain more successful fracturing jobs.

DATA PROCESSING ... This newest member of the fracturing team helps speed data precalculations ... charts information ... performs a multitude of tasks with lightning speed to determine the best engineering combinations for optimum fracturing conditions and results. The rows of processing equipment and giant electronic memory units used here are the largest, most useful facilities of this type ever to be employed by an oilfield service company.

BE SURE YOU GET THESE PREMIUM BENEFITS ON YOUR NEXT FRACTURING JOB! ALWAYS CALL HALLIBURTON!

Visual and permanent records of your fracturing operation on-the-spot ... the HALLIBURTON FRACOMETER! Ask about it.

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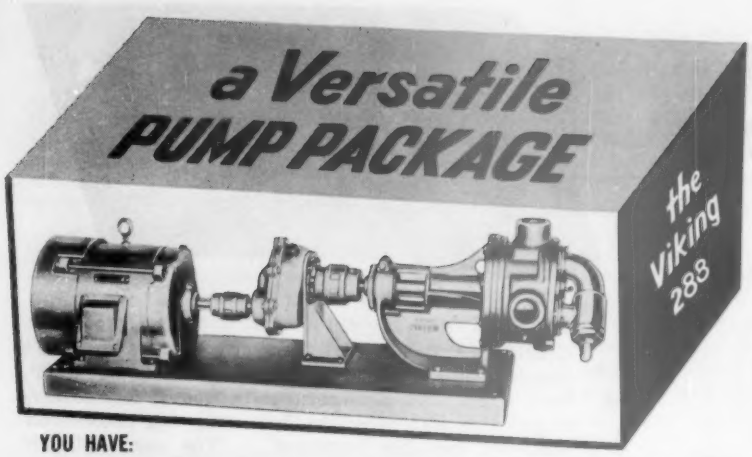
FRACTURING SERVICES

HALLIBURTON OIL WELL CEMENTING COMPANY • DUNCAN, OKLAHOMA

FIRST ... AND STILL FOREMOST ... IN FORMATION FRACTURING



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- INTEGRAL RELIEF VALVE on pump head for positive protection.
- SMOOTH, EVEN FLOW, fast self priming and extra long life — handling thin or thick liquids.
- QUIET, SMOOTH OPERATION of entire unit.
- SIMPLICITY OF SERVICE. Pump, gear reducer and motor are connected with flexible couplings, permitting each component to be serviced separately. Five different sets of gearing can be used in the single oil and weather tight gear case. With four sizes of pumps and five sets of gearings available, capacities range from 17 to 164 G.P.M.
- TOP CONSTRUCTION AND PERFORMANCE — Proved versatile. Meets rigid requirements in a wide variety of applications.

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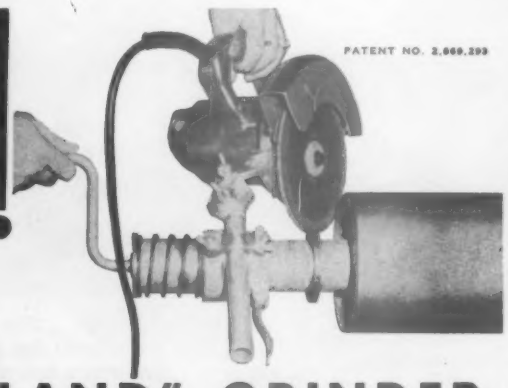


"BEVEL-LAND" GRINDER

automatically cleans and lands pipe bevels

The new H & M "BEVEL-LAND" GRINDER employs an electric grinder to automatically clean and smooth pipe cuts and put the land on bevels. The machine may be placed on the pipe and in operation in less than one minute. A simple adjustment in angle of the grinding wheel is all that is required to change the machine from the cleaning to the land position. The H & M "BEVEL-LAND" GRINDER assures more postive alignment of pipe and better quality welds. The machine is available in two models: one for 6" to 14" and one for 14" to 36" pipe.

WRITE FOR YOUR COPY OF A CATALOG SHEET WHICH DESCRIBES ALL THE FEATURES OF THE NEW H & M "BEVEL-LAND" GRINDER.

H&M TM Reg

PIPE BEVELING MACHINE COMPANY

311 E. Third St. DI 3-0241

TULSA, OKLAHOMA

formerly sales manager of Loomis Machine Co., Tiffin, Ohio. Prior to this, he was a well-drilling-machinery sales representative.

The new division manager spent several years as a well-drilling contractor in West Virginia and Kentucky. In recent years he set up a program of drilling operations for Ranney Methods Water Supplies, Inc., of Columbus.

Burgess-Manning Co. announces

H. A. Dietrich

. . . several new assignments in its Industrial Silencer Division headquarters in Dallas. H. A. Dietrich, vice president and manager of the division, has been transferred to Dallas from Libertyville, Ill., former division headquarters.

Other changes involve: A. P. Gallagher, promoted from chief engineer to engineering coordinator in Dallas; Edmund J. Halter, chief development engineer in charge of the division's research and development program; Bill Golden, chief application engineer; Carl Read, Jr., advertising manager; R. J. McCormick, senior sales coordinator; and P. J. O'Donnell, division accountant, and N. W. Tonchick, chief draftsman, both transferred to Dallas from Libertyville.

R. Z. (Bob) Mendenhall rejoins

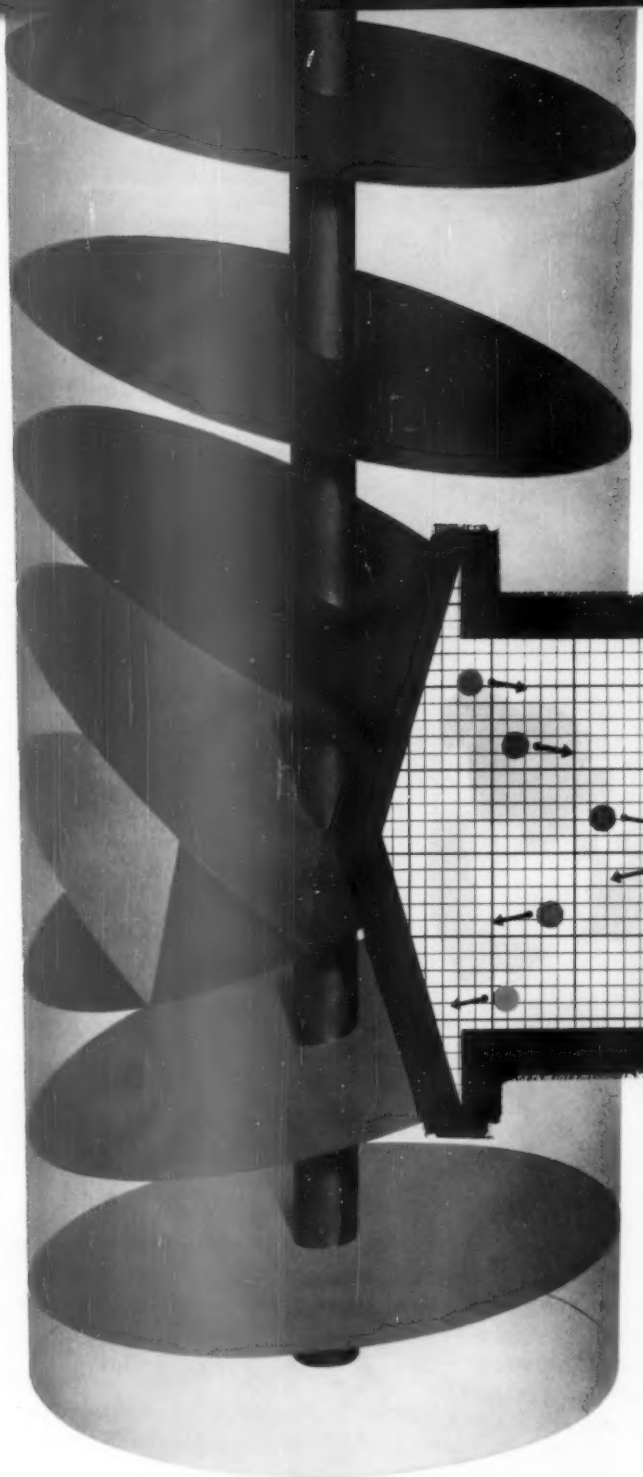
. . . the sales department of Macco Oil Tool Co., Inc. He was formerly sales manager of Guiberson's Gas Lift Division. In his new duties, Mendenhall will act as liason between the Macco Houston office and company distributors throughout the world.

Allis-Chalmers Mfg. Co. makes

. . . several changes in its sales organization.

Charles F. O'Riordan has been appointed manager of the north-central region, Industries Group, succeeding M. M. York, who has been assigned to a new position in Milwaukee. J. A. Sudduth takes over as manager of the St. Louis district, succeeding R. E. Morris, who was named midwest regional manager.

Newly named sales representatives to district offices are Eugene R. Glazier, Denver; Harvey L. Stahl,



FAULTS • SALT OVERHANGS

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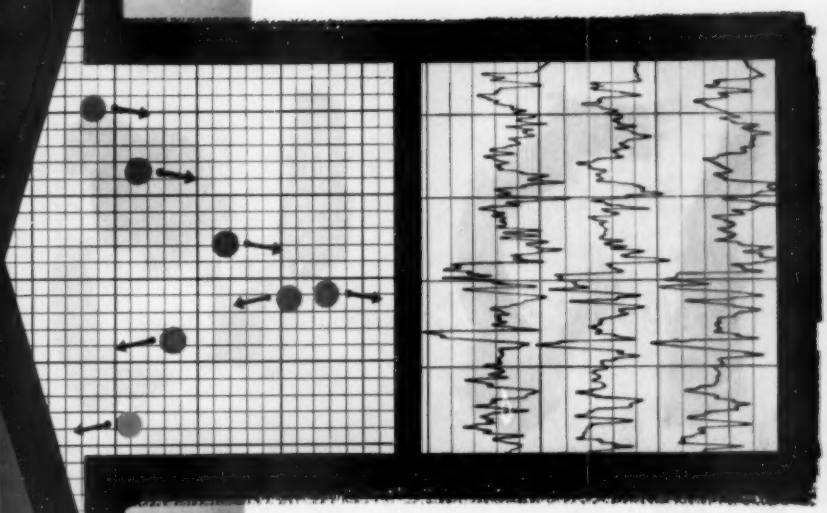
REGIONAL AND STRUCTURAL DIPS

BARS AND PINCHOUTS



the Schlumberger Continuous Dipmeter marks every geological feature!

Closely spaced dip calculations have clearly marked the fault on the graph above. Other structural or depositional features are likewise recognizable by their characteristic dip patterns.

The Continuous Dipmeter gives you a wealth of geological information from a single bore hole. Call your nearest Schlumberger engineer for a discussion of the outstanding results obtained with the Continuous Dipmeter.

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ASHCROFT DURAGAUGES measure pressure with precise accuracy no matter how severe the conditions of service

Ashcroft Duragauges are available in pressure ranges from 15 psi (or vacuum) minimum to 100,000 psi. Dial sizes: 4½" through 12".

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The Bourdon tube in Ashcroft Duragauges is manufactured to precision standards of flexibility and mono-linked to the rotary movement. When pressure flexes the tube, the gauge pointer is always positively positioned, because it is mounted on the geared center shaft of the movement. Sustained high accuracy and long life are assured.

Choose your Ashcroft Duragauges made of components best suited to your needs. Eight Bourdon tube materials are available. Movement of stainless steel with nylon bearings and pinion gear for longest wear. Case materials: special aluminum alloy or tough phenol plastic.

The unique "Maxisafe®" Duragauge provides absolute protection to the viewer, plus easy and quick access to the mechanism. Your industrial supply distributor will help you select the best combination of components for your Ashcroft Gauge requirements. Phone him today or write for Catalog 300B.

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ASHCROFT PRESSURE GAUGES

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MANNING, MAXWELL & MOORE, INC.

Gauge and Instrument Division • Stratford, Connecticut

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

Dallas; and Merlin F. Schwenk, Syracuse.

Kenneth W. Geiser, sales representative in the Syracuse district since 1955, has been transferred to the petroleum and chemical sales section of the New York district. George A. Krail, Jr. has been assigned as a sales representative to the Allentown district.

Geo. E. Failing Co. transfers

. . . Edgar (Ed) Herbst to Dallas as resident sales representative. Herbst formerly worked out of the Failing branch in Houston.

Ernst G. Kuehn is given title

E. G. Kuehn

. . . of European representative by Jefferson Chemical Co., Inc., Houston, announces Ralph E. Werley, Jr., sales manager. Kuehn has worked for Hygrolit, Inc. in operational, sales, and managerial positions in Europe, South America, and the United States. He then went with McKiernan-Terry Corp., of Harrison, N. J.

From 1945 to 1953 Kuehn held executive posts with Heyden Chemical Corp., export division. From 1953 to the present he was involved in foreign marketing operations for the Agricultural & Fine Chemicals Division of American Cyanamid Co.

William E. Ridgeway joins

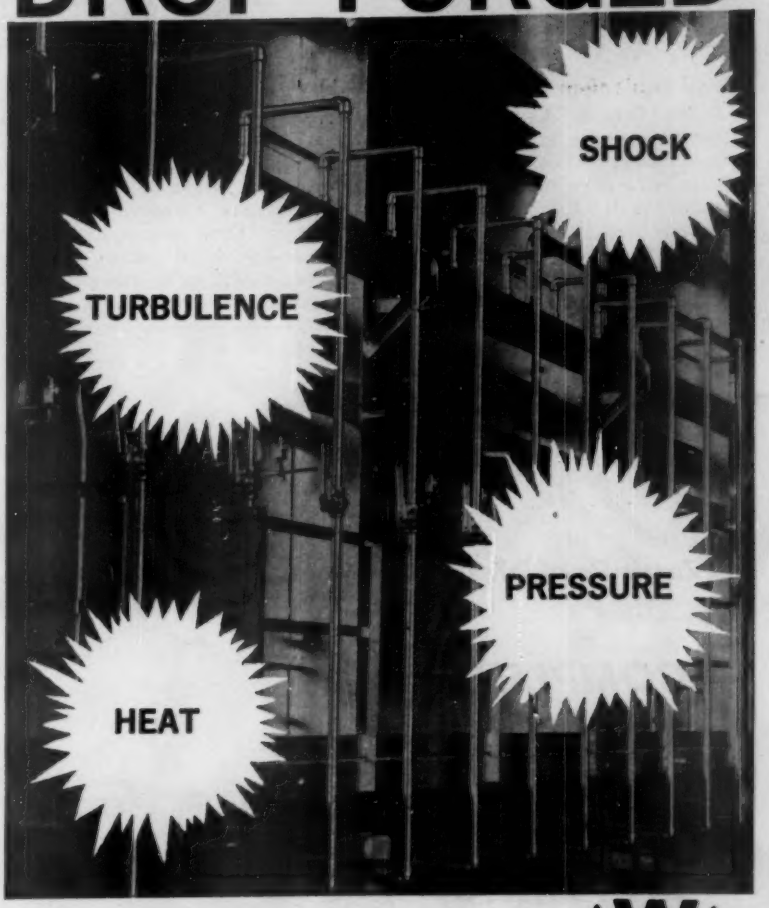
W. E. Ridgeway

. . . Byron Jackson Tools, Inc., as field representative for the Near and Middle East areas, according to Robert Harcus, vice president and general manager of the Borg-Warner subsidiary. Ridgeway will headquarter at Beirut, Lebanon. His territory includes Aden, Egypt, Eritrea, Ethiopia, Iraq, Iran, Kuwait, Lebanon, Saudi Arabia, the Sudan region, Syria, Turkey, and Yemen.

C. S. Hightower is appointed

. . . field engineer by Tex-Tube, Inc., in which post he will cover the Gulf Coast area while working out of the

DROP FORGED



For critical jobs, the brand to look for is W-S

When the piping application is most difficult, that's where you'll find W-S Forged Carbon Steel Fittings. Under the toughest conditions, these are dependable connections which stand up. Here's why:

- Drop forged for exceptionally high tensile and impact strength.
- Long, accurate threads, in perfect alignment.
- Uniform wall thickness, for safety.
- Accurate machining for tight fit.

For specifications and Distributor locations, write *Forge & Fittings Division, H. K. Porter Company, Inc., Box 95, Roselle, N. J.*

FORGE AND PORTER FITTINGS DIVISION

H. K. PORTER COMPANY, INC.

PORTER SERVES INDUSTRY with steel, rubber and friction products, asbestos textiles, high voltage electrical equipment, electrical wire and cable, wiring systems, motors, fans, blowers, specialty alloys, paints, refractories, tools, forgings and pipe fittings, roll formings and stampings, wire rope and strand.

Houston headquarters. Hightower, formerly with Arkansas Fuel Oil Corp., will specialize in line pipe, pipeline design and engineering, oil-well tubing, and completion methods.

Well Equipment Mfg. announces

. . . that Tom S. Andrews, Sr., and Tom S. Andrews, Jr., have joined the organization, according to John W. Gates, vice president and sales manager of the Houston firm. For the past 12 years Tom Andrews, Sr., owner of Tom S. Andrews Co., of Oklahoma City, has been distributor for Hamer products in Oklahoma, Kansas, and North Texas. Tom S. Andrews, Jr., has been with the same company for 3 years as a sales representative for Hamer products in the same territories.

Tom Andrews, Sr., joins Weco as a staff adviser on Hamer products, which are being manufactured and sold by Well Equipment Mfg. He will maintain headquarters in Oklahoma City, where in addition to his staff-advisory capacity, he will continue to serve his customers with Hamer-line blind valves and plug valves, as well as the complete line of Chiksan-Weco products.

Tom Andrews, Jr., joins Weco as sales representative with headquarters in Oklahoma City. He will work with company representatives in Kansas and eastern Oklahoma on the sale of Hamer valves and Chiksan-Weco products.

R. W. Rogers takes over

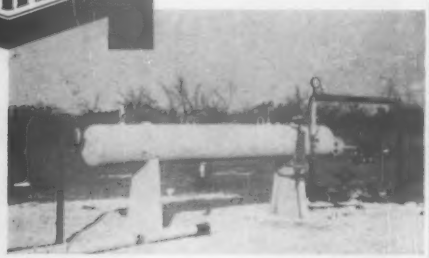
. . . as sales representative in the Kansas territory of Bradford Motor Works. He will headquarter at Lyons. Previous to the appointment, Rogers represented National Supply and Jones & Laughlin Supply Division in Kansas and Oklahoma. He has been associated with oil-equipment companies for nearly 30 years.

Walter A. Anderson named veep

. . . of Procon (Canada) Ltd., announces the board of directors of the Canadian refinery and chemical-plant construction company. Anderson joined Universal Oil Products Co., Procon's parent company, in 1934. He was transferred to Procon as chief estimator in 1953 and was appointed resident manager of the Canadian company 2 years later.

MORAN

In Zavala County, Texas



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. . . all engineered, fabricated, and installed by MORAN

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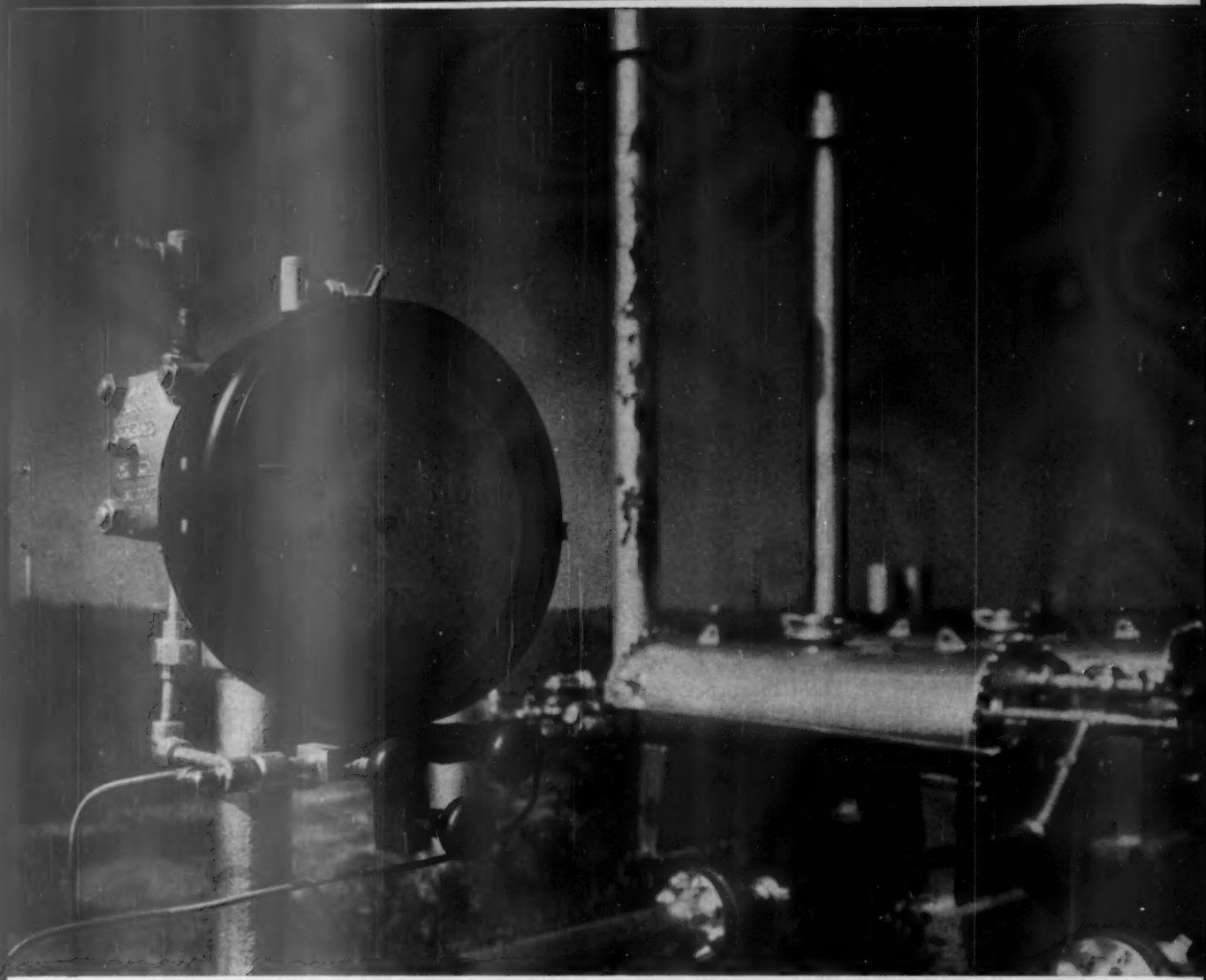
TEST WELL has been completed by Schlumberger Well Surveying Corp. in Houston to test newly built equipment to insure that it functions properly in the field. The well was drilled to 800 ft. with a diameter of 9 in. and logged with every device in the Schlumberger catalog of services. The hole was then reamed to 14¾ in. and a 100-ft. surface string was set. The major design problem was to case the remainder of the hole in order to avoid caving and still to retain the open-hole characteristics necessary for running open-hole logs.



One of the 11 Foxboro T/37 Diaphragm Flow Meters, measuring wet gas to separators, at W. L. Pickens' North LaWard Field, Jackson County, Texas.

"Wet gas can't foul it . . . overrange can't hurt it . . . and it doesn't need maintenance"

THE FOXBORO T/37 DIAPHRAGM FLOW METER

"Undoubtedly the most reliable flow meter we've ever used." That's the report on the 11 Foxboro Diaphragm Flow Meters at W. L. Pickens' North LaWard Field in Jackson County, Texas.

Walter B. Hollow, Drilling and Production Superintendent, states that even though these meters have been in service over a year, none have ever needed re-calibration.

"The Foxboro Diaphragm Meter also eliminates a problem we had of mercury being lost on sudden overranges caused by line surges," Mr. Hollow adds. "And of course, our weekly chore of draining mercury to remove water is a thing of the past."

Producers, pipeliners, plant men — they're all praising this outstanding Foxboro flow meter. Get the complete story on the T/37 in Bulletin 7-15. Or ask your nearby Foxboro Field Engineer. **The Foxboro Company, 605 Neponset Ave., Foxboro, Massachusetts.**

Specially-formed diaphragm discs and solid metal spacer rings insure the T/37 Diaphragm Meter from overrange damage. Spacer rings also protect diaphragm assembly from rupture or distortion by dirt particles — or hyrdates formed in moisture of gas lines.

FOXBORO
REG. U.S. PAT. OFF.

FIRST IN FLOW METERING

Interim Progress Report on CF&I-Wickwire's new wire rope

DOUBLE GRAY-X®

Falcon Seaboard Drilling Company orders carload

The first company to use a prototype of Double Gray-X was the Falcon Seaboard Drilling Company of Tulsa. Aware that modern drilling practices demand the best possible equipment, Falcon Seaboard tested Double Gray-X on some of their rotary drilling rigs, an operation that subjects ropes to extreme abuse. Mr. Jack Starr, Vice President in Charge of Drilling, commented, "The results obtained from original tests with Double Gray-X prototype led to our decision to order *a carload of this improved product.* Falcon Seaboard insists on the best products, in order to serve the oil industry in accordance with today's modern standards."

The Secret of Longer Rope Life

CF&I-Wickwire engineers, after intensive research, discovered that by using an entirely new wire drawing technique—including the use of Molysulfide* in the lubricant—the characteristics of the wire rope were greatly improved. This method creates a permanent molecular jacket around the individual wires that provides these benefits:

- **reduced friction between the individual wires in each strand of Double Gray-X during service**
- **minimized surface imperfections in the wires of Double Gray-X**
- **wires have greater resistance to abrasion, crushing and bending**

If you are a user of wire rope, you can *increase* the safety of your operation and *reduce* equipment downtime with Double Gray-X. Made in a wide variety of sizes and constructions, Double Gray-X is recommended for all types of equipment. For complete details on this new wire rope, call the nearest CF&I sales office or see your local distributor.

Greater Strength

The molecular shield around this new premium wire rope gives Double Gray-X longer life. In addition, you get the *extra strength* for which Double Gray has always been famous. Made of extra improved plow steel with an Independent Wire Rope Core of the same material, this rope gives 15% higher breaking strength than the catalog breaking strength of an improved plow steel rope with IWRC.

*Registered Trademark of Climax Molybdenum Co.

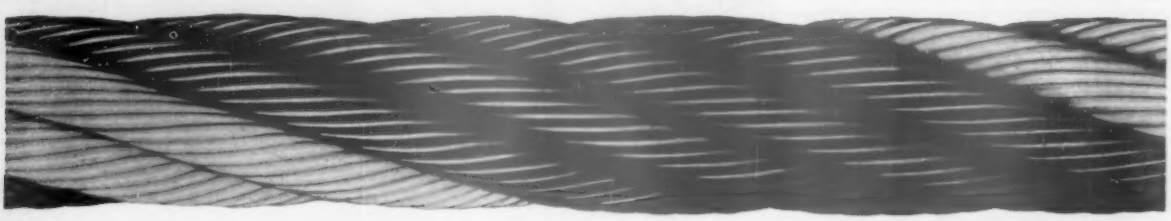
7623-A

CF&I STEEL **WICKWIRE ROPE**

THE COLORADO FUEL AND IRON CORPORATION

In the West: THE COLORADO FUEL AND IRON CORPORATION — Albuquerque • Amarillo • Billings • Boise • Butte • Denver • El Paso • Farmington (N. M.) Ft. Worth • Houston • Kansas City • Lincoln • Los Angeles • Oakland • Odessa (Tex.) • Oklahoma City • Phoenix • Portland • Pueblo • Salt Lake City San Francisco • San Leandro • Seattle • Spokane • Tulsa • Wichita

In the East: WICKWIRE SPENCER STEEL DIVISION—Boston • Buffalo • Chattanooga • Chicago • Detroit • Emlenton (Pa.) • New Orleans • New York • Philadelphia



DEMONSTRATION of a rig is for Spanish group of technicians who are watching mast being raised at Tulsa plant of Fred E. Cooper, Inc.

Rig shows off for visitors

A GROUP from Spain toured the United States to learn more about petroleum operations and oil equipment. One of their stops included a visit to Tulsa where they witnessed a demonstration of a new rig at the Fred E. Cooper, Inc., plant. These Spanish technicians will be largely responsible for the exploration and development of their country's petroleum resources once commercial reserves are found in the homeland or the Spanish Sahara.

Objective of this stop was to evaluate the performances of oil-well servicing, workover, and drilling equipment. Cooper specializes in a line of self-propelled rigs designed for these purposes.

The Spaniards were interested in the new TC-4210-42 double-drum rig rated at 5,000 ft. of slim-hole drilling, or 12,000-ft. workover jobs. The unit uses the same engine power for roading and draw works and has a torque converter, torque-tube drives, and full air-friction clutches. Its 86-ft. mast pulls doubles and is outfitted with hydraulic lifts. The mast can be quickly raised and the rig is running in a few minutes.

The completeness of the unit, its compact dimensions when traveling, and the moderate weights on the tandem rear and front axles favorably impressed the visitors. Aware that much of their overseas operating areas accessible only by light-duty roads and rough terrain, they were interested in these features along with the fact that the rugged I-beam construction of the rig allows it to be roaded at 45 m.p.h. Equipped with air brakes for traveling, the moderate over-all weight can be handled easily with its power steering.

California contractors busy

FIRMS OPERATING on the West Coast have indicated that activity in offshore drilling will be bustling during the latter part of the year. Focal point of interest is Santa Barbara County.

Following a successful core-drilling program, Texaco Inc. will begin building a huge double-deck steel platform in the ocean near Gaviota, 30 miles west of Santa Barbara. To be used for both production and drilling, erection is slated for the middle of May with completion scheduled within 60 days.

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HEVIWATER

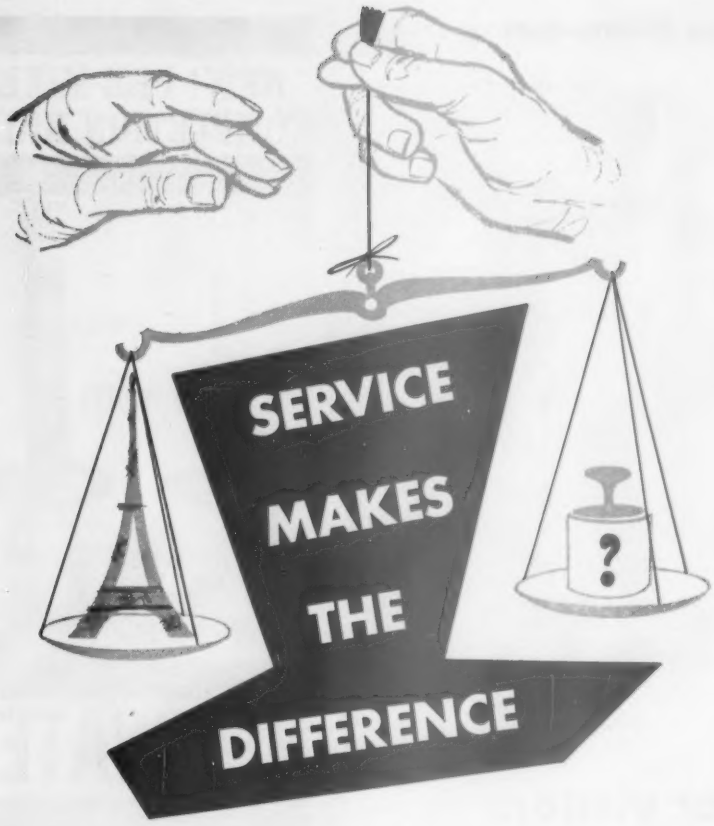
Now—for the first time—you can have all the advantages of a clear, heavy completion fluid without the troubles previously associated with this type of material. A new fluid is now available from Dowell. It's Heviwater*—a pre-mixed, inhibited packer and completion fluid. Heviwater is available in a variety of weights. It is a stable fluid, with built-in corrosion protection. Heviwater is presently stocked at Berwick, Louisiana, but it can be made available at all Dowell stations. Ask your Dowell man for more information on this brand-new, completion fluid; or write Dowell, Tulsa 1, Oklahoma.

*Dowell Trademark

Products for the oil industry

DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY



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Stand lifts, holds, tilts 55 gal. barrels. Prevents spillage—easily loaded.

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OIL WELL, REFINERY AND INDUSTRIAL SUPPLIES
1125 ROTHWELL ST. • P. O. BOX 932 • HOUSTON, TEXAS

Mid Valley, Inc., a subsidiary of Brown & Root, will build the platform. The actual drilling will be done by Caldrill Offshore, Inc., Ventura, a subsidiary of Bell & Burden Drilling Co.

The site chosen is on a 3,840-acre state tract held jointly by Texaco, Monteray Oil Co., and Newmont Oil Co. When completed, the facilities can accommodate adequate space to drill 28 wells. The installation will be situated in 94 ft. of water approximately 1½ miles from land.

Design will include a double platform resting on steel piles driven 70 to 80 ft. into the ocean floor. Its top deck will tower 50 ft. above the ocean surface. The two decks each will be 130 by 138 ft.

Initial construction will be done at Long Beach and the platform supports and deck sections will be floated to location in May. Drilling is expected to begin by August.

The core-drilling that prompted the decision to build the platform was encouraging. One of the tests reportedly flowed over 1,300 bbl. of 35° oil daily.

Texaco will operate for the participating firms. This group paid a record $23,711,538 for the lease.

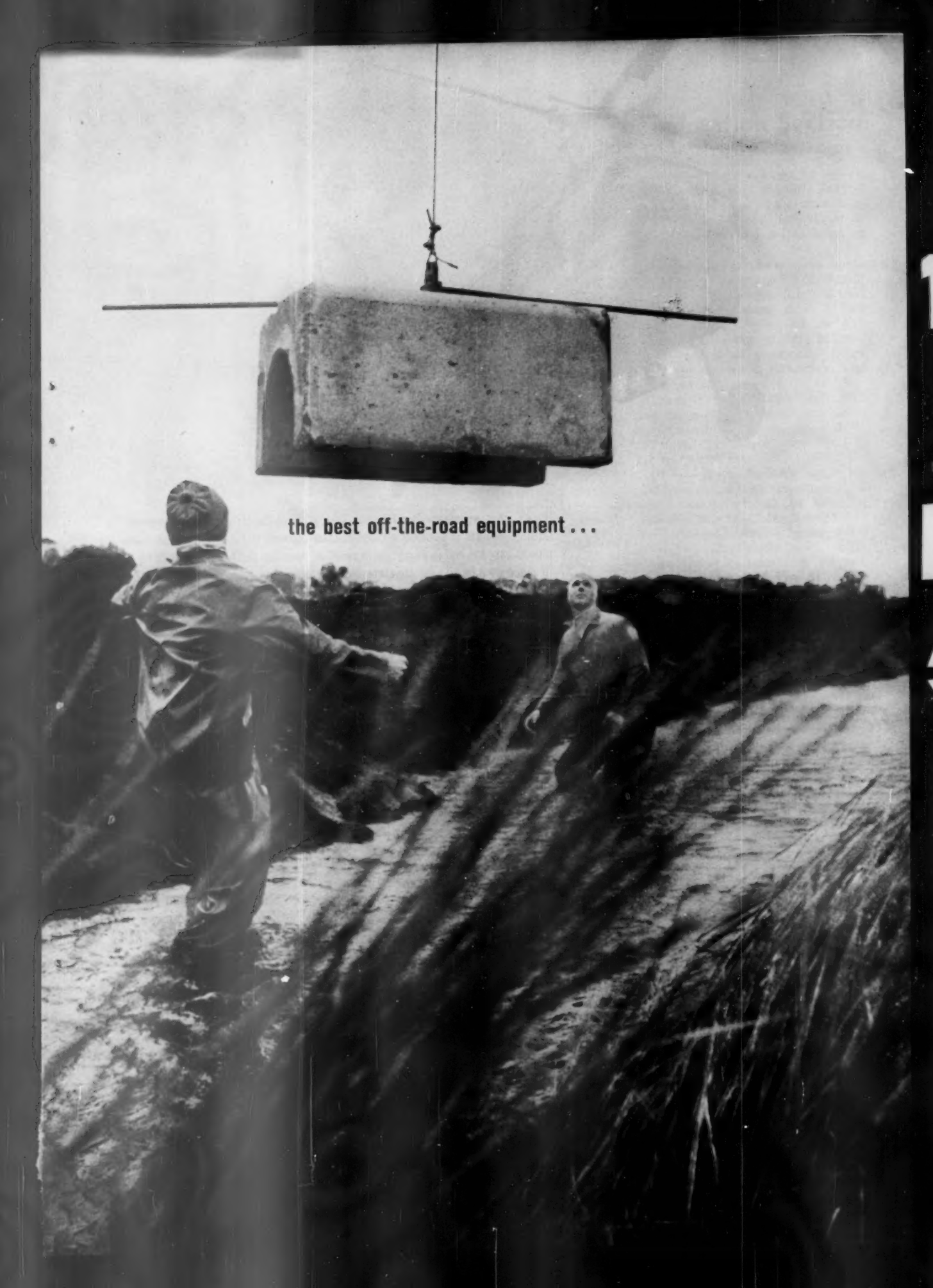
. . . Standard-Humble to build second platform. In mid-June, Standard Oil Co. of California and Humble Oil & Refining Co. will erect their second offshore drilling platform. Drilling will be done by Caldrill.

Their first offshore installation at Summerland is on a 5,500-acre lease. Seven producing wells have been completed in twelve tests. The thirteenth and fourteenth ventures are currently drilling. Daily production from the completed wells is estimated at 1,000 bbl. of oil and 1 M.M.c.f. of gas. Western Offshore Drilling & Exploration Co., a subsidiary of Haney & Williams Drilling Co., Long Beach, has crews on the two rigs working on this platform.

. . . Phillips-Pauley and associates will set a permanent platform. By September Phillips Petroleum Co. and Pauley Petroleum, Inc., will erect an offshore installation about 40 miles west of Santa Barbara in 100 ft. of water on a 3,840-acre lease block.

Space for drilling 33 wells is included in the design of the planned facilities. Phillips will be the operator for the group which paid $5,100,000 for the lease that was purchased in June 1958.

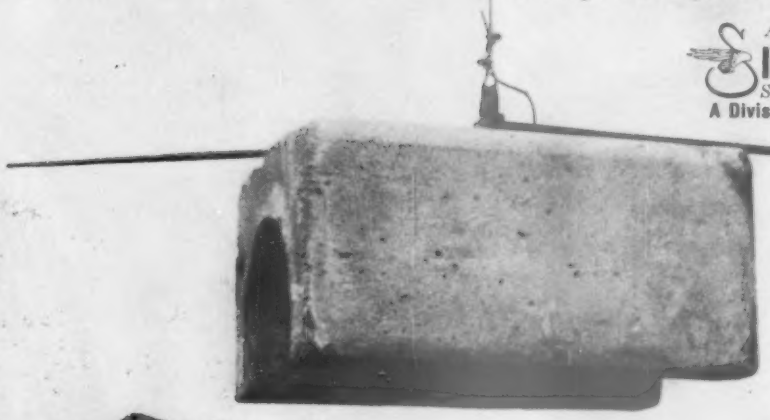
This group has also planned the drilling of a directional well from an onshore site to their second lease block 17 miles west of Santa Barbara. They paid $13,550,000 for the 3,840-acre tract.


the best off-the-road equipment . . .

is off-the-ground equipment

Here's what we mean: The Pipeline Welding and Construction Company of Oswego, Kansas is building a cross-country pipeline in rural Minnesota. Since the pipe is buoyant and is being laid in swamps, marshes and lakes, it has to be anchored in place by 3,000-pound concrete jackets. It used to take 20 men with tools plus 2 sideboom tractors plus 1 dragline boom tractor plus flotation gear plus 10 solid hours of labor to lay 20 of these 3,000-pound concrete jackets. That was before a Sikorsky S-58 helicopter was put to the task. Now it takes just 4 men less than an hour to do the same work. Peewee Vaughn, project foreman, says, "I'll never again do a cross-country job like this without a helicopter." Pilot John Sharbrough says, "The Sikorsky helicopter is the only helicopter that could possibly do this job, and it's a machine that will do everything the manufacturer says it will do." Think about your own business for a moment. There might be a place for Sikorsky helicopters to open up a whole new area of savings. We'll be glad to discuss it with you.

A New World of Mobility by
SIKORSKY AIRCRAFT
Stratford, Connecticut
A Division of United Aircraft Corporation



NORTHWESTERN OCEANIA contains some of the world's biggest oil reservoirs. Wars, politics, and jungle have hindered exploration in this Southeast Asia oil bowl.

Sumatra gives signs of staging an oil comeback

BY JOHN C. McCASLIN

SUMATRA may have a significant new oil discovery, its first in 2 years. Amoseas, the exploration company for the Texaco-California Standard (Caltex) group, reportedly found oil at the Pematang wildcat on its prolific concession in the central part of the Southeast Asia island.

A 2-year lull. The last oil discovery on Sumatra was at Sungei Gelam in 1958 in the southern district. Operators found oil at 1,370-4,700 ft. Cumulative production from two wells here is 41,784 bbl. Newest production in Central Sumatra is at Ukui-Pulai, originally opened 20 years ago, but revived with an extension in 1957. Eight wells there have produced 415,236 bbl.

Caltex produces 150,000 bbl. daily at Minas, the largest field in the area, 20,000-30,000 bbl. per day at Duri. Three smaller fields, Bekasap, Pungut, and Sebanga, are shut in. Minas field crude goes out through a 26 and 30-in. pipeline to Duri. There the line ties into a 30-in., 30-mile flowline to the ocean terminal.

In an old oil arena. Sumatra has had oil production since 1893 when Telaga Said DKG field was born. A primitive refinery was built on River Babalan near the village of Pangkalan Brandan to process this first Sumatran oil. There were later discoveries of little value to the world's oil thirst until 1922 when first South Sumatra oil came in the Palembang area.

. . . 51 fields. There are 31 oil fields in South Sumatra with 406 flowing wells, 686 pumping. Daily output is about 145,524 bbl. Cumulative production is 935,245,312 bbl.

Central Sumatra has 10 fields making 182,638 bbl. daily from 46 flowing wells and 326 pumpers. Cumulative production in this area which includes sprawling Minas field, is 242,-961,845 bbl.

North Sumatra has 10 oil fields, all formerly Royal Dutch-Shell producers. Japan agreed in April to advance about $52,000,000 in equipment, materials, and manpower to put these oil fields back into full operation. A minimum of 12,000 bbl. per day of high-gravity crude is guaranteed to the Japanese for at least 10 years. Negotiations on this deal began more than 2 years ago. If the governments of both Japan and Indonesia approve the contract, it will go into operation next month. The oil contract will have some dark moments if rebels follow their threat of sabotage unless they are included in on the deal.

The oil fields involved in the agreement were never returned to Shell after World War II. Rantau is the best field in the group, making about 15,000 bbl. per day in 1939. Of the 118 shut-in wells, about 80 were believed to be capable of producing. Other fields are Peureulak, Serandjaja, and Belawan.

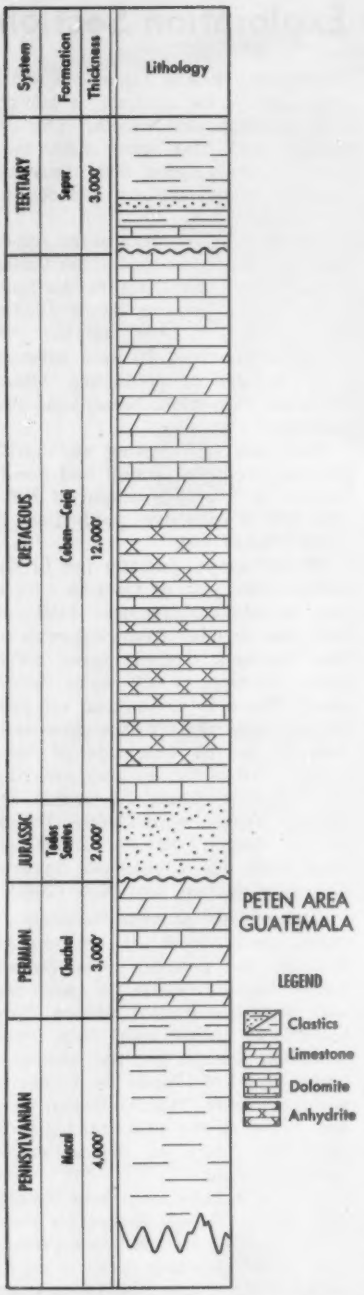
There are 452 flowing and 1,012 pumping wells in Central and South Sumatra with a daily output of 328,-162 bbl. Cumulative production is 1,334,269,157 bbl.

Of vast scope. Sumatra lies in the northwestern part of Oceania . . . a vast island-water-continent hunk of Asia that stretches from Singapore to New Zealand. Oceania spans 4,000 miles east-west, 1,000 miles north-south. There is commercial oil production from the tip of northwestern Sumatra to the west side of New Guinea. All of the oil area, covering parts of five islands, lies within Indonesia except northwestern British Borneo. Sumatra has the largest and most fields. Oil is produced on Borneo, Java, Ceram, and New Guinea.

And geologic promise. Sedimentary basins cover most of northeastern Sumatra and northern Java. Similar basins occupy much of southeast and northwest coastal Borneo. New Guinea is buried with deep, thick sediments except for the mountain core. Most of Papua is blanketed with sediments. This Australian territory is one of the most enticing prospects for future oil exploration in Southeast Asia.

Reservoir rocks throughout Oceania are Tertiary in age except for some Triassic oil on Ceram. Most production is from Miocene rocks at depths of 4,700 ft. or less. The Tertiary section is 30,000 ft. thick in the central part of the huge basinal area. Accumulation is due to anticlines throughout the basin where trapping has taken place mainly in belts of weak and moderate folds. Asymmetric anticlines are common, some overturned and thrust-faulted.

May soon end. Here in Southeast Asia lies a rather large part of the world's oil. Here also lies another one of earth's far-from-tested petroleum coffers. When regional politics and demand get together, there should be a revitalized search for Southeast Asian oil.



TYPE STRATIGRAPHIC section indicates that the oldest sediments in the region representing deep-water deposition are of Pennsylvanian age.

BY JOEL J. LLOYD AND GABRIEL DENGO
Cia. Petrolera de Costa Rica, San Jose, C. R.

This article is based on a paper presented at the annual meeting of the AAPG in Atlantic City, N. J., April 1960.

Only five wells have been drilled in this Central American nation, but . . .

Continued drilling may uncover oil in Guatemala's Peten

PETEN BASIN occupies the low-lying lands on the Atlantic slope of Guatemala, within the Departments of Peten and parts of Alta Verapaz and Izabal. It is characterized by low ranges formed by carbonate rocks exhibiting karst topography, and by wide plains which, when in carbonate sections show mature karst features or when in clastic sediments are flat lying and physiographically undisturbed. The southern portion of the basin is covered by typical tropical rain forest that changes to open-plains country in the center of the area and grades to swampland and scrub growth in the north.

Regional Geology

The Peten basin, so known from published literature and in common industry terminology, is a misnomer that should be recognized to avoid pitfalls in geologic correlation and interpretation. The inference to be drawn from the name is that we are dealing with a completely contained geosynclinal unit whose sediments are derived from older rocks immediately adjacent to and around the Peten region. Actually the Peten basin is a small part of a great basin that extends northward and northwestward into Mexico (and may include the Macuspana basin of Tabasco and the Yucutan platform), and eastward through British Honduras continuing an unknown distance under the Caribbean.

The Peten region, and the major basin to which it pertains, is terminated in the south by the metamorphic and igneous core of Central America which trends southeast to northwest, from northern Nicaragua through Honduras and Guatemala and into the Department of Chiapas, Mexico. The extent of the Paleozoic basin is unknown, but a major uplift at the end of Paleozoic time produced a barrier in eastern Alta Verapaz and northern Izabal, the Sierra de Santa Cruz, that remained a positive element throughout succeeding geologic time. The Maya Mountains of British Honduras, with a spur extending into the Peten, are a result of the same orogeny.

South of the Sierra de Santa Cruz barrier, the Lake of Izabal represents the western end of the Bartlett trough, a relatively young Tertiary depression.

To the east of the trough there is evidence of a Cretaceous basin in northern Honduras, and there is reason to believe that these basins, though not continuous, were interconnected through gaps in the barriers from time to time.

Structure

For the purpose of discussion we have divided the area into five major structural units; the Alta Verapaz fault belt, the Foreland, the Chiquibul embayment, the Libertad arch, and the North basin.

Alta Verapaz fault belt. The Alta Verapaz fault belt is an arcuate zone, concave northward, that extends in front of the Paleozoic uplift for approximately 35 miles, to a line generally equivalent to an arc drawn from the Chinaja anticline through the headwaters of the Rio Moho. It is comprised of a series of faults, thrust to the north, in which the older Cretaceous has been pushed over younger Cretaceous, and younger Cretaceous over Eocene, in a repeated sequence. There is no evidence of younger Tertiary sediments being involved in this period of faulting and we believe that the orogeny, associated with renewed movement in the uplifted Paleozoics, began in Upper Cretaceous and did not continue beyond upper Eocene.

Foreland. The Foreland, in front of the faulted belt, extends to just north

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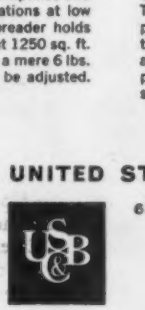

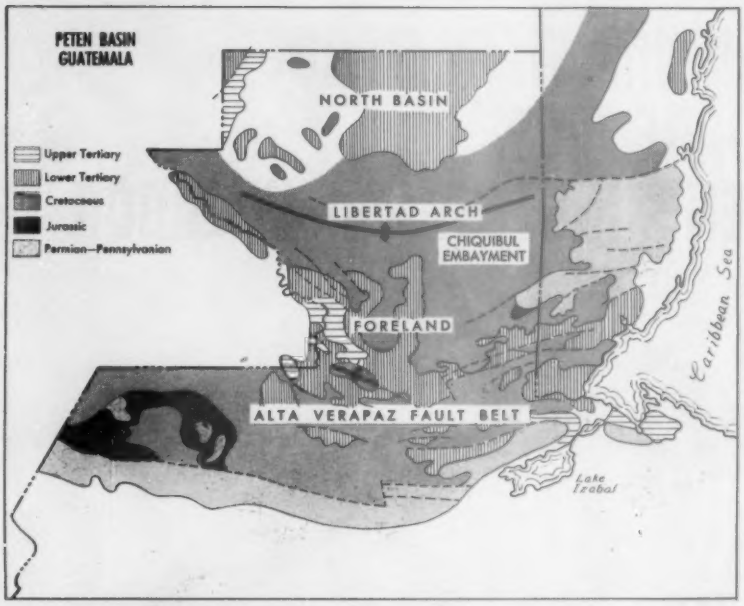

AREAL DISTRIBUTION and regional geologic features of the Peten basin in relationship to adjacent areas is displayed.

of the Rio Subin. It is a relatively stable structural element with gentle folds and minor faults. The tectonic grain of the Foreland is generally parallel to the arcuate front of the Alta Verapaz fault belt, although structural trends become divergent and patternless at the turning point of the arc.

Chiquibul embayment. The Chiquibul embayment, although essentially a part of the Foreland, merits separate attention because of its stratigraphic trap possibilities that will be later discussed. It lies at the northeast corner of the Foreland between the spur of the Maya Mountains and the crossbasin high known as the Libertad arch.

Libertad arch. The Libertad arch is an east-west crossbasin high that is significantly aligned with the west-trending mass of the Maya Mountains of British Honduras. The age of the Libertad movement is one of the major problems confronting the petroleum geologist in Guatemala today.

It is proposed therefore, that the arch may be related to the Paleozoic orogeny, that it may represent the low front of a tilted block of which the Maya Mountains form the high back; and that the entire chain is hence parallel to the uplifted block that marks the southern limit of the Peten basin.

Further evidence can be adduced in the alignment of the abrupt northern termination of the Maya Mountains in British Honduras with a pronounced scarp south of the Lake Peten that marks the north limit of the Libertad arch in Guatemala. This alignment can be followed with precision on maps prepared from a recent aereomagnetic survey. If this theory is true, Mesozoic and Cenozoic sediments deposited over the Libertad barrier should be expected to show considerable thinning. The results of both the aereomagnetic survey and of recent drilling has demonstrated that this is the case.

North basin. The North basin, within the Peten region, appears to be another relatively stable element. There is reason to believe that the basement underlying the North basin plunges northward out of Guatemala and rises again to the Yucutan platform. A consideration of the stratigraphic sequence, evaporites in the section, suggests the possibility that the North basin was shallower than the Foreland during Cretaceous time, and subsided at a rate that maintained a constant level proportionate to the accumulation of sediments on its sea floor.

Stratigraphy

Pennsylvanian-Permian. The oldest sediments within the region, representing deep-water deposition in Pennsylvanian time, are the interbedded dark gray to black shales, argillites, and minor graywackes of the Macal formation. Approximately 4,500 ft. of formation have been measured resting on a basement complex of igneous and metamorphic rock.

Elevation of the area in the Permian resulted in the deposition of the Chochal formation, 3,000 ft. of interbedded fossiliferous limestone, dolomite, sandstone and shale, conformable on the underlying Macal. The formation outcrops in a band along the Paleozoic uplift south of the basin but has never been observed to the north where it may be missing from the section.

Jurassic. Total emergence at the end of the Permian was sustained through the Triassic and most of Jurassic. The Upper Jurassic-Todos Santos formation is thus separated by a major unconformity from the underlying Pennsylvanian-Permian sediments. The formation is composed of red sandstones and conglomerates with minor brackish water deposits, littoral shales, and some evaporites. The thickness of the formation is extremely variable with 3,700 ft. measured in its type section at the south of the basin. The formation thins rapidly northward and eastward to approximately 300 ft. in the neighborhood of the Maya Mountains.

Cretaceous. The Jurassic - Cretaceous contact is conformable and probably gradational in parts of the basin. The Cretaceous beds, which reach thicknesses in excess of 12,000 ft. in the southern part of the basin, are composed almost entirely of limestones, dolomites, and anhydrites, with only minor occurrences of clastic sediments. In the south the evaporites appear to be restricted to the lower part of the section and may be confined to shallow-water occurrences along the basin's edge. From the Libertad arch northward, however, the evaporite sequence is contemporaneous with the carbonates throughout the Cretaceous.

Facies changes of Upper Cretaceous rocks together with onlap and wedge-out of the carbonates of Lower and Upper Cretaceous over the uplifted older beds within the Chiquibul embayment, point to this area as highly prospective for finding stratigraphic traps.

Tertiary. An unconformity exists locally between the Eocene and the Cretaceous. Continued deepening and turbidity on the Foreland during the Eocene resulted in the deposition of more than 3,000 ft. of silty limestones, siltstones, shales, sandstones, and conglomerates.

In the North basin the carbonate and evaporite depositional sequence of the Upper Cretaceous was continuous into the Eocene.

Emergence at the end of the Eocene resulted in only fragmentary deposition of Oligocene sediments within the basin. The Miocene is represented by

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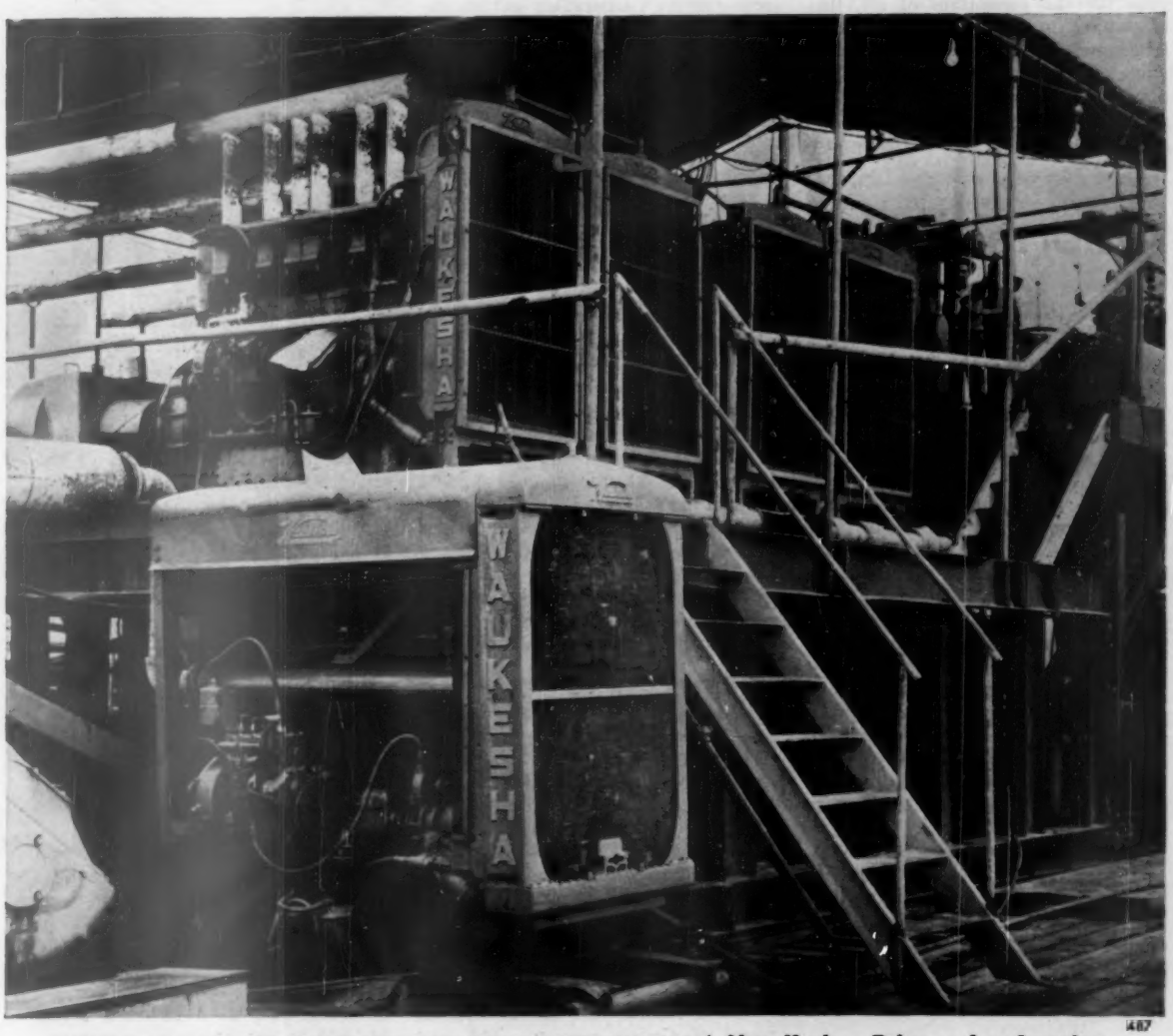

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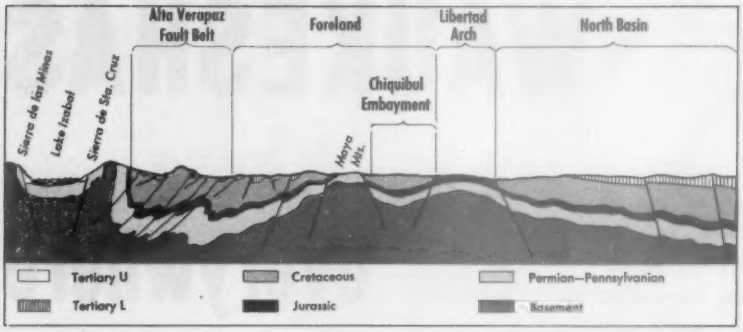

THIS IDEALIZED south-to-north cross-section across the Peten basin is unscaled.

clastics in patches along the western edge of the Foreland and the North basin.

Petroleum Geology

The black shales and highly fetid carbonates of the Permian-Pennsylvanian strata are considered to be source beds for the generation of oil, that may have migrated to the Chochal limestones and the good clastic reservoirs of the Jurassic formations. The apparent unconformity between Permian and Jurassic, however, and the variable deposition of the Todos Santos make the pre-Cretaceous section a secondary objective for the region.

The highly organic and porous carbonates of the Cretaceous section are demonstrated source and reservoir rocks. Live oil in outcrop and shows encountered in the wells drilled, have made the Cretaceous the primary objective of the Guatemalan section. Interfingering of carbonates and evaporites on structure and in stratigraphic traps, and thick limestone beds under Tertiary cover, should provide commercial pools in the basin.

The Tertiary clastics and silty limestones are not considered to be of economic importance except as a cap for those Cretaceous sections without evaporites.

Conclusions

Five wells have been drilled in Guatemala, of which two were doubtfully within the basin area and did not reach the Cretaceous sediments. The other three (one of which is still drilling) all found repeated oil shows in the Cretaceous limestones and dolomites. In a basin of the size of Peten it cannot be expected that 3, or 5. or 10 wells, will supply all of the answers. It is known that oil has been generated and that reservoir beds exist, and that adequate caprock is present and that structural and stratigraphic traps can be found. It is also known, however, that many of the best drilling prospects will be in the areas so difficult of access that the cost of moving equipment to location will be extremely high. Nevertheless, it is believed that the Peten region is a high-ranking prospect in the frontier regions of the world today, and that continued drilling should result in a commercial discovery.

Alberta drilling yields to spring mud

"King Mud" and his running mate "Spring Road Ban" took over the oil areas of Alberta during the later part of March and the first few weeks in April, and pulled exploration and development work to a stop in many areas and a very slow walk in other spots.

But in Alberta's treasury department, more active movement than usual was noted during the first week of April. The billionth dollar in revenue from petroleum and natural gas for the province was rung through the till in that period. That is the billionth dollar received from the sale of Crown Reserve Rights, rentals on lands issued, and royalties on production from those lands since January 1, 1947—a period extending over 13 years, 3 months, and 1 week, and encompassing western Canada's modern oil history.

The old adage that the first million is the hardest to come by might be altered by the movement of the decimal point to the first billion in this case, for the province is off and running on its next billion-dollar return from the fabulous and fast-growing oil industry.

April sale. First substantial payment on the next billion came on April 21, with another of the now-famous Alberta Crown Reserve land sales. At that recent sale the oil companies that make up the industry put out hard cash as proof of their faith in Alberta's future in this department. In excess of 11 million dollars came in from the sale of 23,023 acres of oil and gas-developed rights. The signs of faith ranged all the way from a low of just over $12 per acre for a wildcat land parcel up to $3,125.35 per acre for proven oil rights in the Swan Hills producing area of West Central Alberta.

Swan Hills. Swan Hills field dominated the sale, returning $6,044,-331.06 from the sale of 12 land tracts in the proven sector of the field, and $1.4 million from semiproven parcels. The total of 32 field parcels that were sold brought in $9,413,777 and interesting wildcat lands netted the Crown $2,192,677 at this particular sale.

If the results of the latest Crown Sale and revenue received in the initial quarter of the year can be used as an effective yardstick, 1960 should prove to be a record year for Alberta in terms of Crown revenue. The first quarter was better than average with the three separate sources of revenue tallied in the listing of revenue from Crown Petroleum and natural-gas rights revealing a total income of $36,-181,212.20 in the initial 91 days of this year. Of this total, 19.4 million dollars came from sale of Crown Reserves, 8.4 million dollars from rentals on lands issued by the Crown, and 8.2 million dollars from royalties on production.

This first-quarter revenue pushed cumulative income since January 1, 1947, within a stone's throw of the billion-dollar mark, and the figure was actually eclipsed in the first week of April. From January 1, 1947, to March 31, 1960, over $529,912,411 has been realized from sale of Crown Reserves, an additional $240,312,452 has resulted from rentals on those lands, and $226,597,137 came in from royalties on production.

Record year in this income was 1947 when $134,359,860 was paid into the government coffers, while second-highest year in the province's history came in 1956 with $133,052,550 accruing from this particular source. Last year, meanwhile, proved to be a third-best year as it returned $131,-412,615 to the Treasury from petroleum and natural gas.

IN 1959. We learned some amazing facts about...

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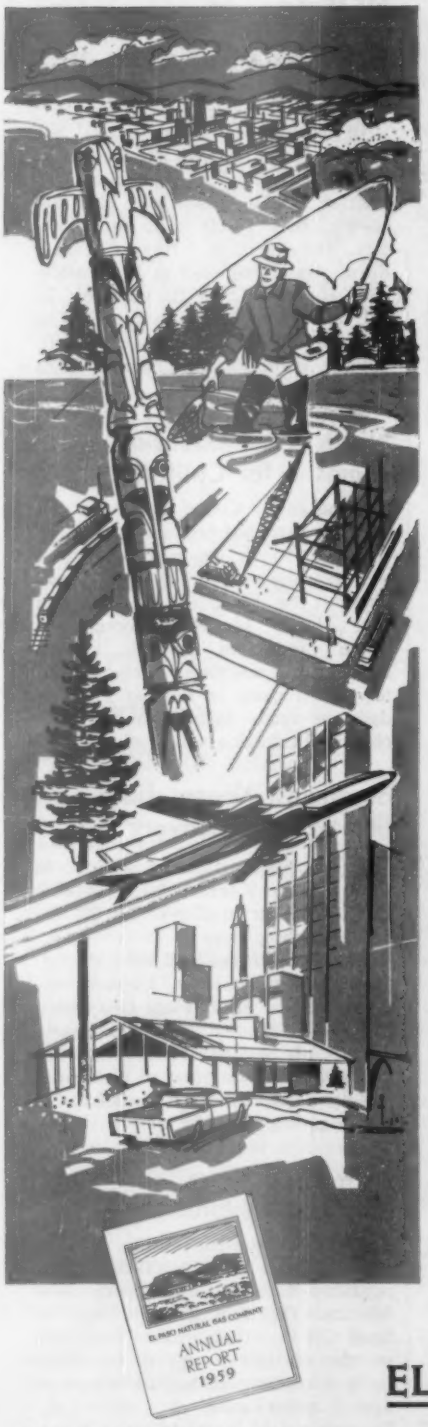

Did you know that the normal summer temperatures in Seattle and Portland, largest cities in the Pacific Northwest, have the delightful range of 56° to 79°? Or that their winter temperatures are in the moderate 35° to 45° range? Or that annual precipitation in these booming economic centers is under 40 inches (less than New York City or Little Rock) with little snow?

The facts about the climate of Seattle, Portland, Spokane, Tacoma, Olympia and other Pacific Northwest cities were not a surprise to us. But we didn't know that Portland's winter weather was more moderate than in Louisville, Kentucky. We didn't know that Seattle's summers were cooler than in Portland, Maine.

In fact, when El Paso Natural Gas Company began to serve this dynamic region, we learned a lot of new things about a northwest wonderland destined for an increasingly major role in America's economic future.

Washington and Oregon, and their neighboring states, are on the go. Long famed for natural resources, for scenery, for vitality, the Pacific Northwest's growing population and expanding economy are a guarantee of future prosperity.

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* * *

Not the least of the Pacific Northwest's economic assets is natural gas, furnished by El Paso Natural Gas Company. In 1959, El Paso took major steps to assure energy supplies for the Pacific Northwest, and to continue to meet the mounting energy demands of California and the Southwest, whose growth has paced the nation since World War II.

The dynamic Pacific Northwest is featured in photographs in El Paso's 1959 Annual Report. El Paso's broadened service area and plans for the future, outlined in this Annual Report, assure 11 Western states the dependable long-term gas supplies so necessary to sound and speedy economic growth.

NORMAL TEMPERATURE AND PRECIPITATION, SELECTED CITIES IN PACIFIC NORTHWEST*

	SUMMER TEMPERATURE	WINTER TEMPERATURE	ANNUAL PRECIPITATION
SEATTLE:	56°-75°	36°-45°	31.92 inches
PORTLAND:	58°-79°	35°-44°	39.91 inches
SPOKANE:	57°-82°	20°-30°	14.92 inches
TACOMA:	55°-74°	34°-44°	35.20 inches
OLYMPIA:	49°-76°	31°-43°	45.74 inches

*Weather Bureau, U.S. Department of Commerce.

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El Paso Natural Gas Company provides natural gas to industrial customers and distribution companies in Arizona, California, Colorado, Idaho, Nevada, New Mexico, Oregon, Utah, Washington, West Texas and Wyoming.

New zone for California's Wheeler Ridge field

A new zone discovery in the Windgap area of Kern County's Wheeler Ridge field was being credited to Kern Oil Co. of California, Ltd. The Kern Oil test was originally completed on the north edge of the area play last September as a routine development well. The operator recently went back into it, resqueezed at 8,102 ft., about 250 ft. below the old producing zone, and reperforated it selectively in an area between the "JV" and "Z" sands. On a formation test, the newly perforated zone made 720 bbl. of oil rate through a 16/64-in. choke. The operating was perforating the "Z" sand before recompleting the well was a new zone discovery.

Rio Vista deep test completed in California

Solano County's Rio Vista gas field failed to turn up deep commercial production in a wildcat drilled by Standard Oil Co. of California; however, it was completed in a shallower interval by another operator.

Standard of California took the test, 11 Peter Cook, to 15,044 ft. without success. Amerada Petroleum Corp. took over the hole, plugged it back to 4,522 ft. and completed it as a field-development well in the Emigh zone at 4,230-54 ft. and 4,265-80 ft. for 675 M.c.f.d.

California's La Honda pool extended

In Central California's coastal San Mateo County, Neaves Petroleum Development Co. extended production in their recent La Honda new pool discovery about 2,000 ft. to the southeast. The extension, 1 Neaves-Texaco-Burns, was completed in the shallow interval 1,267-1,328 ft. pumping 72 bbl. daily of 16.9°-gravity crude. The operator took the test to 4,015 ft. initially before plugging back to 1,328 ft. for the completion.

North Tejon extension comes in for California

Standard Oil Co. of California successfully extended production in Kern County's North Tejon field with a well ¼ mile east of the nearest producer. The Standard of California test, 318-16 Muzinich Community, found production between 11,810-12,224 ft. in selectively perforated intervals. It came in flowing 115 bbl. daily of crude through a 48/64-in. choke. Production was cutting 0.1%.

Southwest Kansas bags three-zone discovery

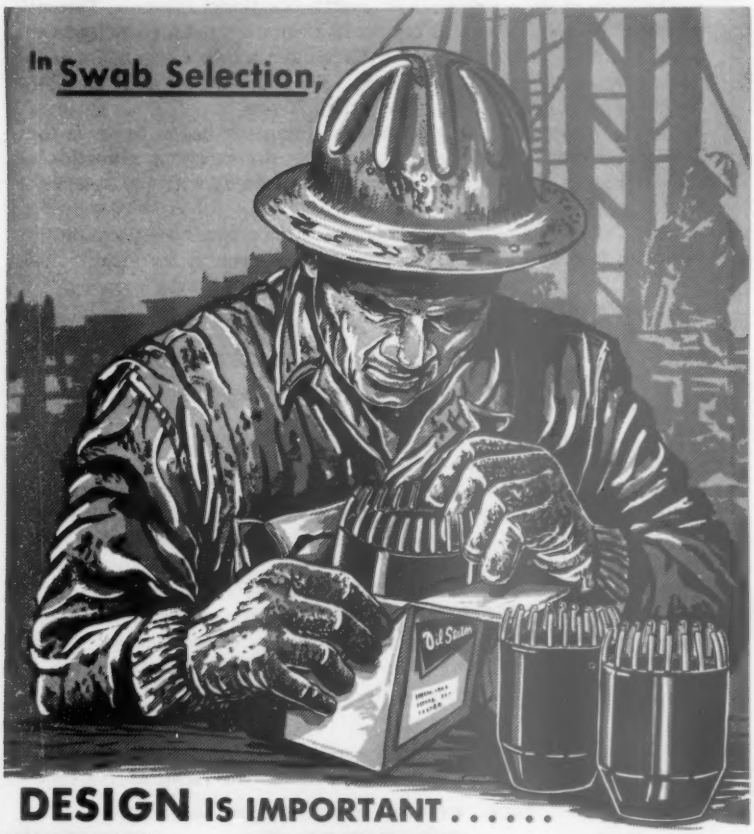
A Comanche County wildcat in southwestern Kansas, J. M. Huber Corp. 1 Keller in C NW SE 22-32s-18w, has three pays.

The well flowed 3,500 M.c.f.d. from Mississippian at 5,104-41 ft., 8,190 M.c.f.d. from Viola Ordovician at 5,600-42 ft., and 30-40 bbl. hourly from Viola at 5,642-95 ft. The wildcat is 4 miles southeast of Coldwater and 8 miles northwest of Beals Lansing and Simpson gas field.

New Mexico well may tap Devonian

Devonian gas-condensate production is hinted at a 12,300-ft. wildcat in Eddy County, southeastern New Mexico. The indicated discovery is Shell Oil Co. 1 Henshaw Deep Unit on the northwest edge of Henshaw field, 10 miles northeast of Maljamar and 5 miles south of Lucky Lake Devonian field in 24-16s-30e.

Gas flowed at 10 M.M.c.f.d. during drill-stem test at 11,682-11,718 ft. Recovery was 10 bbl. condensate in



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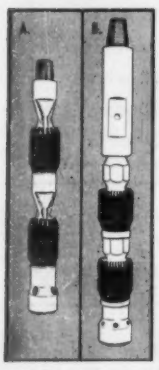

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test tank and 870 ft. of condensate and 60 ft. oil-cut salt water in the drill pipe. The well also had some showings in the Pennsylvanian at 8,765-8,881 ft.

Ohio's Muskingum gets new gas pool

IN OHIO, John Adams reports indications of a new Clinton gas pool on completion of 1 Carl R. Eppley, 1Q Lot 5 in northeast Falls Township, Muskingum County.

The test topped the sand at 3,541 ft. and was only drilled to 3,581 ft. when natural production of 1,900 M.c.f.d. was gaged in the pay from 3,576-81 ft. Recorded 16-hour rock pressure was 1,030 psi.

Vinton. The latest development in Swan Township, Vinton County area is the recent completion by David Law 1 Dana Beyers, Section 3, which had a reported flow of 200 bbl. of oil in 1½ hours in the first test after fracture.

This stepout is about 1½ miles north of the gas play and about ¾ mile south of Mount Pleasant oil pool. The Clinton sand was found at 2,896-2,919 ft. and had a showing of oil and gas natural.

Williston pay may change name

THE STRATA belonging to the shale and lenticular sandstone sequence which has been called the Heath formation of Mississippian age in the Williston basin is of economic importance as a source of oil in southwestern North Dakota.

Information has accumulated to indicate that these sediments are Pennsylvanian in age and are correlatable, at least in part, with the Tyler sandstone in the Sumatra area of Central Montana. The name Tyler formation is, therefore, proposed for these sediments in North Dakota.

This formation is found over much of western North Dakota and may possibly be equivalent to sediments which occur over much of South Dakota. The Tyler of the Williston basin in North and South Dakota rests unconformably on truncated Big Snowy (Otter and Kibbey) and on truncated Paleozoic strata. It is overlain by carbonates of the Minnelusa and/or Amsden formations, and locally by sands and shales of the Jura-Triassic.

A dark gray to brown fossiliferous limestone which overlies the Tyler sediments in parts of North Dakota is believed to be a stratigraphic equivalent to the Alaska Bench member of the Amsden in Montana.

The Tyler formation varies from 0 to 300 ft. thick in North Dakota. A detritus deposit composed of pre-unconformity rock types have been recognized in cores and samples from the base of the Tyler. Over much of North Dakota the formation is black, carbonaceous, fossiliferous shale; however, over many areas as much as a few feet to the upper one-half of the formation is dark red shale. Locally red, maroon, yellow, and green shales occur in the upper 20 to 40 ft. of a predominantly black-shale interval.

Sands are developed more extensively in the black-shale unit, but occur in some areas in the red shale. Toward its outer limits to the north and east in North Dakota, the Tyler becomes more sandy and red colors are dominant. In areas where the Tyler has red shales above and dark gray to black shales below, the sequence appears to be lithologically similar to the Tyler formation in the Sumatra area of Central Montana.

Apparent correlatives of the Tyler formation in South Dakota exhibit varicolored shales, and tan carbonates

From the North Dakota Geological Society's Geologram.

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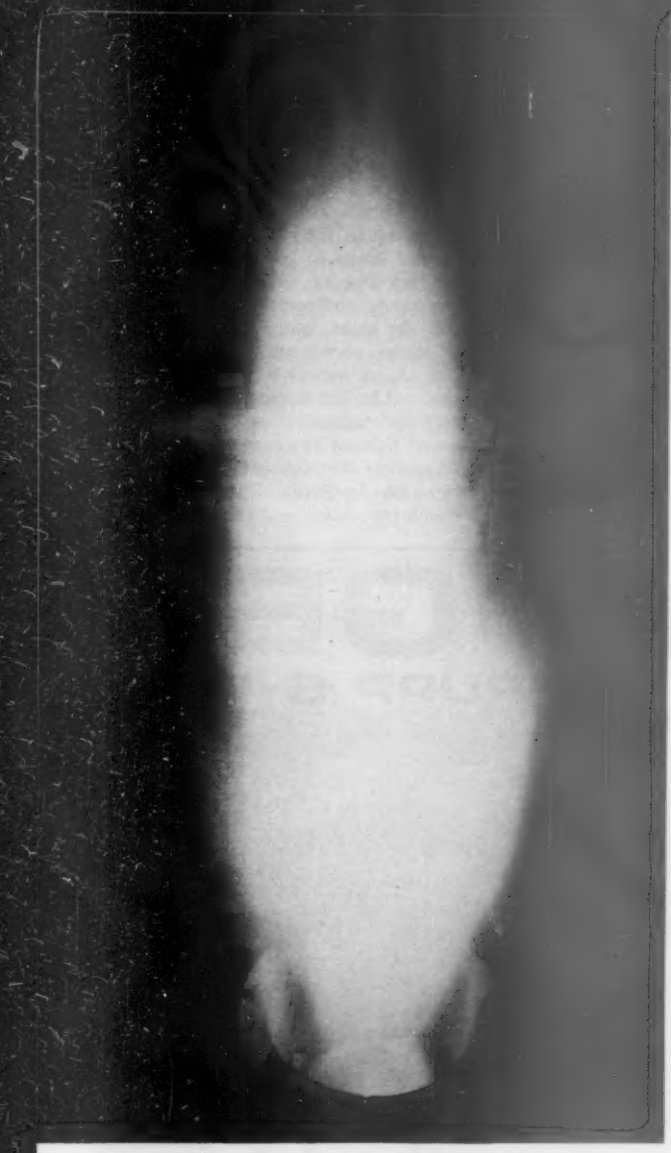

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An unretouched photo of John Zink DB burner being fired in one of the John Zink research furnaces.

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WRITE FOR BULLETIN D-59

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in the upper half, with dark green and black shales and dark-colored limestones and sand in the lower half. A sand at the base, called Fairbanks by earlier workers, lies across the truncated edges of Madison and older Paleozoics.

The sands in the Tyler appear to be bar-type sand lenses which are channeled into the basal detrital beds, and occur interbedded with black to red and varicolored shales in higher parts of the unit. A near-shore lagoonal, fresh-water to marginal marine environment seems apparent. Fossils indicate a Pennsylvanian age for these sediments in North and South Dakota and suggest correlation with "true Amsden" at least in part.

Tyler sand oil fields, in southwestern North Dakota have produced, since the first discovery in 1954, an accumulated total of 364,615 bbl. of oil as of July 1959.

Cores from this formation on the Nesson anticline have had good oil shows in well-developed porous sands, and suggest that more oil is yet to be found in these strata.

Shallow Arbuckle well flows in South Oklahoma

A shallow discovery is reported on the Carter-Garvin county line in southern Oklahoma. It is Mid-America Minerals .1 Prince in SW SW 32-1n-2w. Gas flowed 439 M.c.f.d. from 812-1,276 ft. Clean oil recovery at 1,142-1,275 ft. was reported.

A test of the Arbuckle Cambo-Ordovician at 1,450-1,505 ft. got 310 bbl. of oil daily. A test at 1,450-1,536 ft. flowed 230 bbl. per day.

Oklahoma Panhandle well confirms Morrow discovery

Official confirmation to a recent Morrow Pennsylvanian gas discovery in Texas County, Oklahoma Panhandle, is reported by Cities Service Oil Co. Their 1 Hier "A" in SE NW 21-5n-15eCM, 13 miles northeast of Guymon and 1 mile south of the discovery well, Hamilton Bros. 1 Dailey, flowed 6,800 M.c.f.d. during tests at 6,110-26 ft. Drilling continues below 6,205 ft.

Texas' Palo Pinto adds shallow gas find

A prolific and shallow gas wildcat well in the Palo Pinto gas area of North Central Texas has been reported by Pan American Petroleum Corp.

It is believed to be one of the largest gas discoveries in terms of productivity in the long history of that area.

Pan Am's 1 Lane was completed for an open-flow potential of 52.5 million cubic feet of gas and 95 bbl. of 63°-gravity condensate a day on a 4-hour test. Recovery was from the Big Saline conglomerate through perforations 3,752-67 ft. Nearest Big Saline production is believed to be about 4 miles southeast of the 1 Lane, near the town of Brad.

The 1 Lane is located in Section 14, Block 4, T&P Survey in extreme east-central Stephens County. It was drilled to a total depth of 3,925 ft., plugged back to 3,816 ft. The Big Saline has been the object of active gas wildcatting in western Palo Pinto County in the past year.

The well is located on a jointly owned 1,700-acre lease block, with Pan holding 75% interest and operating. The M&W Co. owns the other 25% working interest.

Beaver's Como area moves northeast

Como field in Beaver County, Oklahoma Panhandle, moved 1 mile north and 1 mile east as a result of two successful wells.

Ohio Oil Co. 1 Baggerly Tract 29, C SW NE 29-2n-25eCM, gaged 154 bbl. of oil in 8 hours from openings at 7,724-34 ft. in the upper Morrow Pennsylvanian sand.

The other well is Jake L. Hamon 1 Reiswig in C NE SW 20-2n-25eCM. This well is shut in after returning an unreported oil flow from 7,601-16 ft. Como field has only 1 well. It lies 7½ miles east of Elmwood in 30-2n-25eCM. The Hamon well will link this field with Northeast Como which is linked to Mocane field.

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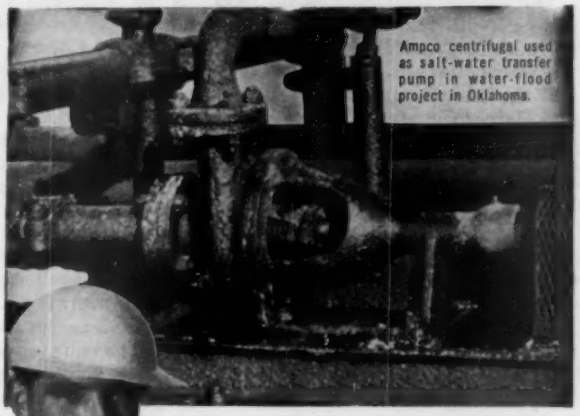

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VALVES

Pre-Permian may soon overshadow Panhandle's Permian producing area, as . . .

Big Mocane, Laverne fields link up

Kenneth Chasteen, Managing Editor
Dwight's Panhandle Oil Explorer
Amarillo, Tex.

THE Amarillo-Hugoton area, which currently boasts the world's largest continuous petroleum-producing area, a combination of the Permian production in the Panhandle oil and gas field and the Hugoton gas area, is speedily developing a Pre-Permian producing area, which many believe will soon rival it.

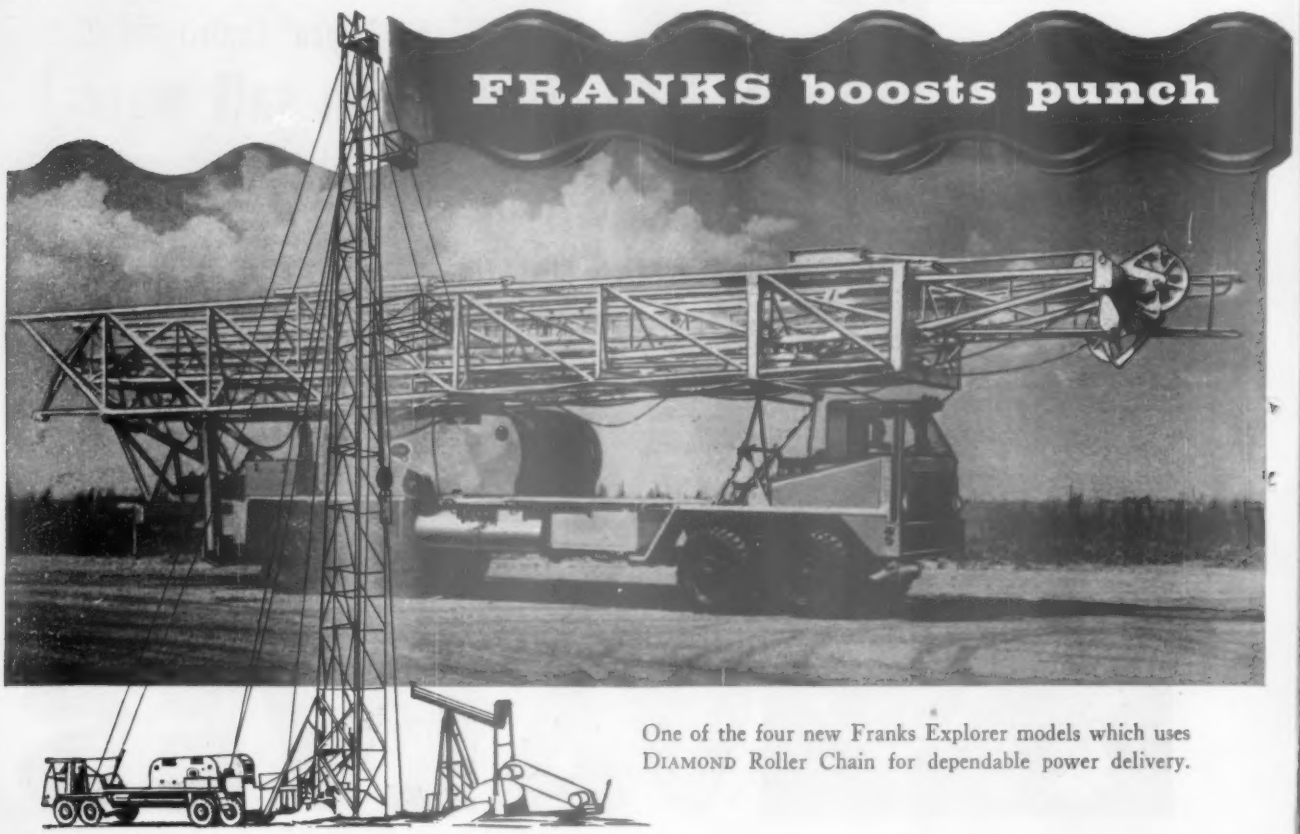
During the latter portion of 1959 and early this year, a breakneck drilling pace has succeeded in combining the Mocane gas area of Beaver County and the Laverne gas area of Beaver and Harper County, Oklahoma. Linkage was accomplished by Cabot Carbon Co. of Pampa with its 1-15 Barby Ranch Unit in 12-3n-26eCM of Beaver County. Opening Lovell-Endicott gas production at a point 3 miles south of the nearest comparable production in the combined area, the venture joins the same firm's 1-11 Barby Ranch Ranch Unit in 1-3n-26eCM, cased for Tonkawa completion, to link the two fields with a two-section-wide coupling. Potential was 6,270 M.c.f.d. through open casing from the 1-15 Barby.

A matter of one well separates the fields from joining by a southerly route. Currently active in 4-2n-26eCM is the Sinclair 1 Klepper which has already commenced production tests from the Chester. This combination measures some 52 miles from its most easterly producing section to its most westerly producing section. There are some 27 miles from its most northerly producer to its most southerly producer, and growth continues daily.

30 years. Initial production in the now combined area was opened by the Sinclair 1 Howell in September 1930. This Tonkawa gas discovery opened the Laverne gas area in Section 14-26n-24w with a potential of 11,000 M.c.f.d. and 65 bbl. of condensate per day. Development consisted of this well until 1947, when a second well was added. A third well was not drilled until 1952.

Mocane. The year 1952 also saw first production in what was later set up as the Mocane gas area. Discovery was the Pure 1 Albert in 16-5n-26eCM. Originally set up in Northwest Knowles field, the well made 2,700 M.c.f.d. from Morrow perforations 6,615-38 feet and open hole at 6,718-75 feet.

As late as 1954, some 20 miles still separated the Laverne and Mocane gas areas. Rapid development in Beaver County prompted the Oklahoma Corporation Commission to set up the following fields as the Mocane gas area: West Beaver-Panhandle, West Forgan, South Forgan, East Forgan, Southeast Forgan, Northeast Knowles, Northwest Knowles, Mocane, Northwest Mocane, Southwest Mocane, Southeast Mocane, Southwest Camp Creek, West Timber Creek, Ridgeway, Northwest Ridgeway, and the South Ridgeway. Development in 1959



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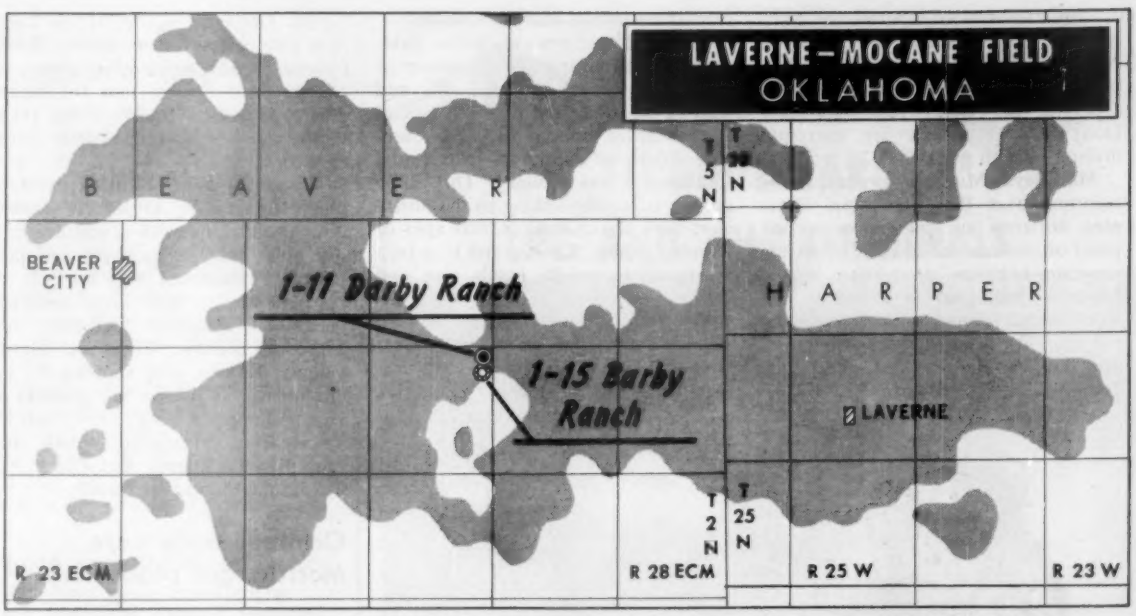

ONE OF THE northwestern Anadarko's biggest stories yet is the linkup of Laverne and Mocane fields.

linked Clearlade, Northeast Como, Como, Northeast Forgan, North Knowles, South Glenwood, Glenwood, and Glenwood Gate Lake field to the area. Proper placement of less than a half-dozen edge wells will add the Northeast Elmwood, Northwest Elmwood, South Six Mile, Six Mile, and two as-yet-unnamed producing areas during 1960.

The Laverne gas area has seen much the same type of development since 1954. Fields merged into it include: East Stockholm, West Stockholm, Southwest Stockholm, South Stockholm, Northwest Laverne, Northeast Laverne, Highland, Madison, Southwest Madison and Sunnyside. In 1959, the South Laverne field was added and one producer could add the five-well Northwest May field.

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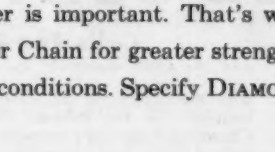

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Only two sections separate the combined Mocane-Laverne gas area from Northwest Doby Springs field of Harper County and two other sections separate this field from Northeast Doby Springs. Wells are currently drilling in both gaps.

Multipays. Multipay production is common over the huge area. Some nine horizons are productive at one point or another and if one counts the separate horizons productive in the Morrow, this total is raised to 11. Represented in one or more section of the field are Council Grove, Toronto, Hoover, Lovell - Endicott, Tonkawa, Lansing, Hodges-Kansas City, Morrow (three levels), and the Chester.

The rapid growth of the field, coupled with an increasing amount of discoveries being drilled south and west of the area, lead many to predict a near-future linking with the Camrick district of southwest Beaver and southeast Texas County. This same growth is rapidly linking to the northwest with the Adams Ranch area of Meade County, Kansas, and it in turn is expanding rapidly north, east, and west.

Growth also seems to be moving steadily south from the central Beaver County portion of the field towards Ochiltree and Lipscomb counties, Texas. The same is true of the Camrick district in western Beaver. Continuous production covering almost all of Hansford County and the bigger part of Ochiltree County in the Texas Panhandle is spreading steadily north to meet it.

A combination of all these developments leads many to foresee continuous production, with a scattering of dry holes marking porosity and permeability pinchouts, over the bulk of Harper, Beaver, and Texas counties, Oklahoma, Hansford, Ochiltree, and Lipscomb counties, Texas and Meade County, Kansas. Also showing for inclusion in this picture are portions of Hemphill and Roberts County in Texas, Ellis, Woodward, Woods, and Major in Oklahoma and Clark, Seward, and Morton in Kansas.

Ochiltree adds more Morrow gas production

Ochiltree County in Texas' Panhandle has another Morrow Pennsylvanian gas-producing area. Discovery well is Stekoll Petroleum Corp. 1-16 Cavins-Jarvis in Section 16 of the E. C. Hooper Survey, 3 miles southwest of Wamble Upper Morrow gas field.

Stekoll finaled the discovery flowing 18 M.M.c.f.d., open flow, calculated. Perforations in the Morrow sand were at 8,174-84 ft.

Mississippian. A gage of 1 M.M. c.f.d. was reported at a northwestern Ochiltree County wildcat, the James F. Smith et al. 1 Pearl Witt in Section 47, Block 11, W. Ahrenbeck Survey.

Production is from Mississippian at 8,050-60 ft. Nearest similar gas is 5 miles southeast at West Perryton field.

Stekoll also has confirmed a recent Morrow gas discovery, the 1 Gonden, at its 1 Schneider in Section 93, Block 11, of the W. Ahrenbeck Survey. The confirmation well is 1 mile northeast of the discovery well. It flowed 2 M.M.c.f.d. from perforations at 7,612-20 ft.

Rare Montoya discovery hinted in West Texas

Pecos County in West Texas has an apparent Montoya Ordovician discovery 10 miles south of Imperial. El Cinco Production Co., Ltd., 1-C C. A. Atkins is the well.

Flow was 17 bbl. of new oil in 1 hour through perforations at 5,252-62 ft. More perforations are being made at 5,202-52 ft. in the upper Montoya zone which lies above the Simpson. Location is Section 26, Block 10, H&GN Survey, in South Pecos Valley-Ellenburger field.

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New Illinois field is expanding fast

A new Rosiclare Mississippian field is developing at a fast clip 3 miles north of Mattoon in Coles County, Illinois. Development Associates, Inc., completed the discovery well in January at 1 Tracy in NE NW NE 27-13n-7e. It pumped and flowed 140 bbl. per day, natural, from Rosiclare at 1,902-12 ft. There are six wells in the area now. Production gages up to 164 bbl. per day from Rosiclare are reported.

William Zuhone, Jr., completed two wells in Rosiclare. One made 84 bbl. per day, the other 55. He also has one testing. M. H. Richardson made 20 bbl. of oil per day at another well in the area.

Photo directories of Dallas societies now available

The 1960 photo directory of the two Dallas geological and geophysical societies has been published and is currently being distributed to the 750 members of the societies.

In addition to the membership photos, the directory contains a listing of the past and present officers, committees, a crossreference by company affiliation, roster of independents, and the constitution and bylaws of each of the societies.

Copies of the directory can be obtained by nonmembers for $2 each. They are available from the Secretary, Dallas Geological Society, Box 253, SMU Station, Dallas.

Other society publications available include the Geological Highway Map of Texas for $1 and the Cooke-Grayson County and Ouachita Symposiums for $10 each.

Reworking old well brings Texas success

REWORKING an old gas-condensate well in the East Sheriff area of Calhoun County, in Texas' central coastal sector, has opened another productive sand in the field.

The well is Quintana Petroleum Corp.'s 1 Emma Runk. It originally was completed in 1949 with gas-condensate production at 8,800-12 ft. The new completion is at 8,932-38 ft. with a rated open-flow potential flow of 55 M.M.c.f.d. of gas.

This sand is the deepest of seven sands which have been found productive in the field so far. Including the new deep zone, six of the sands are gas and condensate reservoirs. They are at 8,000, 8,250, 8,400, 8,700,

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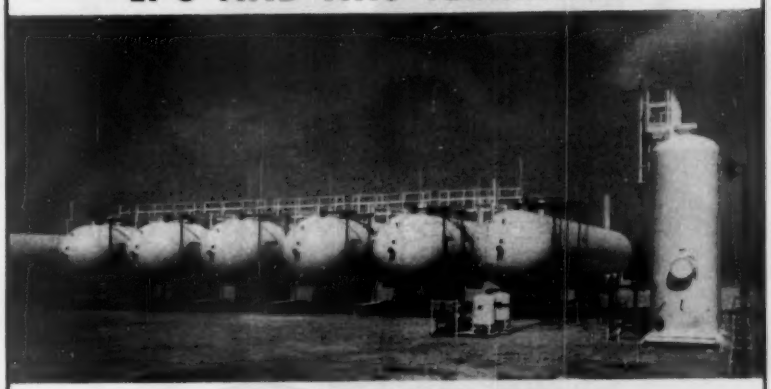

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8,800, and 8,900 ft. The other sand, at 8,100 ft., carries oil.

Gas flow in the new completion produced 58.5°-gravity condensate in the ratio of nearly 30 bbl. per 1 M.M.c.f. Shut-in pressure on the tubing is 3,192 ft.

The well had been drilled to 9,440 ft. before its original completion, and thus required no deepening for the new completion in the deeper zone.

Louisiana well opens new Wilcox pay

New Wilcox production is being opened in a discovery by E. C. Wentworth and associates northwest of Security in eastern Catahoula Parish, eastern Louisiana.

Discovery well, a 2-A Cotton and others flowed 81 bbl. of 38°-gravity oil per day through 6/64-in. choke from perforated pay at 3,851-53 ft. It is in the Stewart "B" zone. Bottom of hole is 3,940 ft.

Nearest other production is in Omega field, 3 miles northeast in Concordia Parish. Location spots in 42-7n-6e.

Wentworth also is completing another Wilcox discovery well about 10 miles northeast in Concordia Parish. On preliminary tests, this well, 1-E Fisher, in 2-7n-7e, flowed 15 to 20 bbl. of 34.6°-gravity oil daily. It will be completed on the pump.

Its pay is the Stewart "A" sand, perforated 3,737-45 ft. Location is a little more than a mile northeast of Moro, and about 1½ miles northeast of Athlone.

Fourth wildcat set for Alaskan basin

ALASKA'S Yakutat basin on the southeast side of the state will get its fourth wildcat this summer. Colorado Oil & Gas Corp. will begin sometime in July according to Alaska Oil Report in College. Barges are being loaded in Seattle with drilling equipment and supplies. The wildcat will go to 11,000 ft. on a large seismic anomaly near the Dangerous River.

Colorado. Colorado Oil & Gas Corp. is operator for itself, Continental Oil Co., and Frankfort Oil Co. The group holds joint interest in about 1,000,000 acres lying between Icy Bay and Cape Fairweather along the Gulf of Alaska near the deepwater harbor of Yakutat.

The southeastern part of Alaska is pelted with 130 in. of rain and snow per year. But it is served well by

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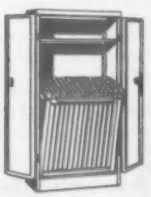
MAP  FILE

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transport facilities—good roads, airports, and housing facilities.

The new well site is 15 miles southeast of previous drilling which began in 1956. The 1 Yakutat was spudded after 1956 exploratory work on March 2, 1957. Honey & Williams drilled the first well. The 2 and 3 wells were drilled by Colorado with a company rig. All three wells had good gas shows. The third well almost blew out at 10,848 ft. It was abandoned in April 1959. Several sidetracking and redrilling attempts were futile. A good Tertiary section was found at this well, upping the interest in the region's oil prospects.

Rugged terrain. The many large, swift rivers in this area that begin in the high mountains flowing across a flat land 70 miles long and 5-18 miles wide. Most of the acreage held by the group is on this land southeast of Yakutat. Timber covers one-third of the area. Road building is difficult and expensive. Water is the best means of transport. Colorado has a Navy LCU which will accommodate most of the equipment used in ordinary drilling operations.

To reach the well site for the new wildcat, Athey wagons, Bombardier trackers, and the LCU barge will be used. The Situk River will be the roadway for transportation. Cargo from Seattle will land at Yakutat beach, be loaded onto the boat, and moved inside the mouth of the river about 8 miles from the drill site. From there it will travel 8 miles overland.

Discovery Wells

WESTERN CANADA

Alberta:
Hudson's Bay-Union 8-28 Kaybob, LSD 8, 28-61-18w5. Capped potential Gilwood gas well. TD 10,649 ft.

NORTH LOUISIANA

Catahoula Parish:
E. C. Wentworth et al. 2-A Cotton-Reeves-Justiss-Albritton, 42-7n-6e, 2¾ miles northwest of Security. IP 81 BOPD, 6/64-in., 38°, TP 500 psi., GOR 400 cu. ft. per bbl., perf. 3,851-53 ft., Wilcox. TD 3,940 ft. New-field discovery.

SOUTH LOUISIANA

Plaquemines Parish:
Anderson-Pritchard Oil Co. 1 State Lease 3091, 23-20s-28e. IP 29 BOPD (net), 70% b.s. and w., 41 M.c.f.d., 14/64-in., 31°, TP 750 psi., perf. 13,396-13,400 ft. TD 14,758 ft. Discovery well South Adams Bay field.

Point Coupee Parish:
Phillips, Phillips & Guy 1 Smith, 5-6s-9e. IP 118 BOPD, 9/64-in., 42.4°, GOR 525 cu. ft. per bbl., TP 540 psi., perf. 9,689-98 ft. TD 10,947 ft. New pay in Livonia field.

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Serio-Punches Oil Co. 1-D Norman

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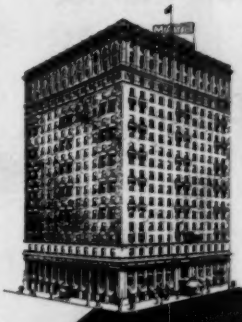

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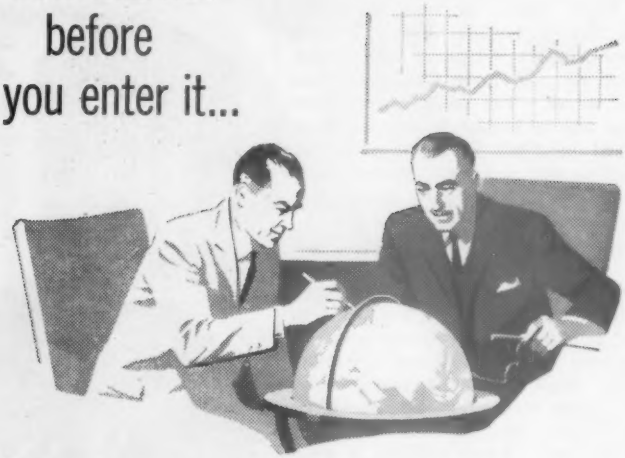

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Breaux, 2-4n-4w. IP 107 BOPD, 12/64-in., 48.3°, TD 170 psi., perf. 6,917-21 ft., Wilcox-Minter sand. TD 7,021 ft. Elev. 68 ft., Wilcox 4,770 ft.

Clarke County:

Broadhead & Stack 1 Land, NW SW SW 9-1n-17e. IPP 45 BOPD (net), 15-20% water, 17°, perf. 3,774-78 ft., Eutaw. TD 4,162 ft. New-field discovery.

J. A. Kennington-Thurber & Miller 1 G. L. Keeton et ux, NE NE SW 5-1n-17e. IPP 44 BOPD (net), 42% water, 17°, perf. 3,714-18 ft., Eutaw. TD 4,104 ft. New field.

Wayne County:

Lyle Cashion Co. et al. 1 E. M. Jarrett et al., SW NE SE 27-10n-6w. IP 125 BOPD, 14/64-in., 33°, TP 75 psi., perf. 8,750-57 ft., Rodessa. TD 12,039 ft. Elev. 254 ft., Lower Cretaceous 6,150 ft., first Rodessa sand 8,658 ft., Hosston 9,176 ft., Cotton Valley 11,085 ft. Discovery well Cypress Creek field.

NEBRASKA

Cheyenne County:

Exeter Drilling Co.-Falcon-Seaboard 1 Schuessler-State, C NW SW 16-15n-52w. IPP 110 BOPD, "J" sand discovery, new field. TD 5,455 ft.

NEW MEXICO

Eddy County:

Castle & Wigzell 1 Delhi-State, 33-17s-28e. IPF 96 BOPD, 10/64-in. choke, 42°, TP 910 psi. Abo reef 5,890-5,930 ft. TD 6,084 ft. New oil discovery.

Chambers & Kennedy 2 Delhi-State, 14 miles east of Artesion in 34-17s-28e. IPF 456 BOPD, 21/64-in. choke, 42°, TP 810, CP 285 psi. Abo reef open hole 6,289-99 ft.

Ralph Lowe 1-RB Federal, 12 miles southeast of Malaga in 18-25s-30e. IPF 68 BOPD, 20/64-in. choke, 42°. Delaware sand 3,643-49 ft. TD 3,666 ft. New oil discovery.

Lea County:

Shell Oil Co. 2 Querecho Plains Unit, OWPB, 27-18s-32e. IPF 193 BOPD, 20/64-in. choke, 39.4°, GOR 780:1, TP 280 psi. Bone Spring 8,538-60 ft. TD 14,330 ft. PBTD 8,657 ft. Originally completed as Atoka gas discovery. New oil discovery.

San Juan County:

Albert C. Bruce, Jr. 1 Richardson, NE NW 4-30n-14w. IPP 24 BOPD, 41.2°, Gallup 5,040-5,123 ft., Gallup discovery, new pool. TD 5,123 ft.

NORTH TEXAS

Grayson County:

Superior Oil Co. 1 W. R. Younger, OWWO, 3½ miles southeast of Whiteboro in BBB&C Sur., A-143. IPP 111 BOPD, 30°, 5,250 ft. TD 5,358 ft. New oil discovery.

Wise County:

American Trading & Producing Corp. A-1 J. V. Hampton, Charles Frazier Sur., A-294. IPAOF 8,500 M.c.f.d., GOR 30,300:1. Bend 6,499-6,510 ft., 6,184-88 ft., 5,951-56 ft. TD 6,900 ft. New gas discovery.

Young County:

W. R. King 1 McAnulty, 10 miles southwest of New Castle in Sec. 737, TE&L Sur., 4-741. IPF 264 BOPD, 41°, Strawn 3,410-22 ft. TD 4,708 ft. New oil discovery.

SOUTHWEST TEXAS

Brooks County:

Humble Oil & Refining Co. 12 Santa Fe Ranch, San Salvador Del Tule Grant, A-45, 9 miles southeast of Encino. AOF 31 M.M.c.f.d., GLR 50.3 M.c.f.

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There are no mechanical complications in a Nash Compressor. A single moving element, a round rotor, with shrouded blades, forming a series of buckets, revolves freely in an elliptical casing containing any low viscosity liquid. This liquid, carried with the rotor, follows the elliptical contour of the casing.

The moving liquid therefore recedes from the rotor buckets at the wide part of the ellipse, permitting the buckets to fill with gas from the stationary Inlet Ports. As the casing narrows, the liquid is forced back into the rotor buckets, compressing the gas, and delivering it through the fixed Outlet Ports.

Nash Compressors produce 75 lbs pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

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No internal wearing parts.

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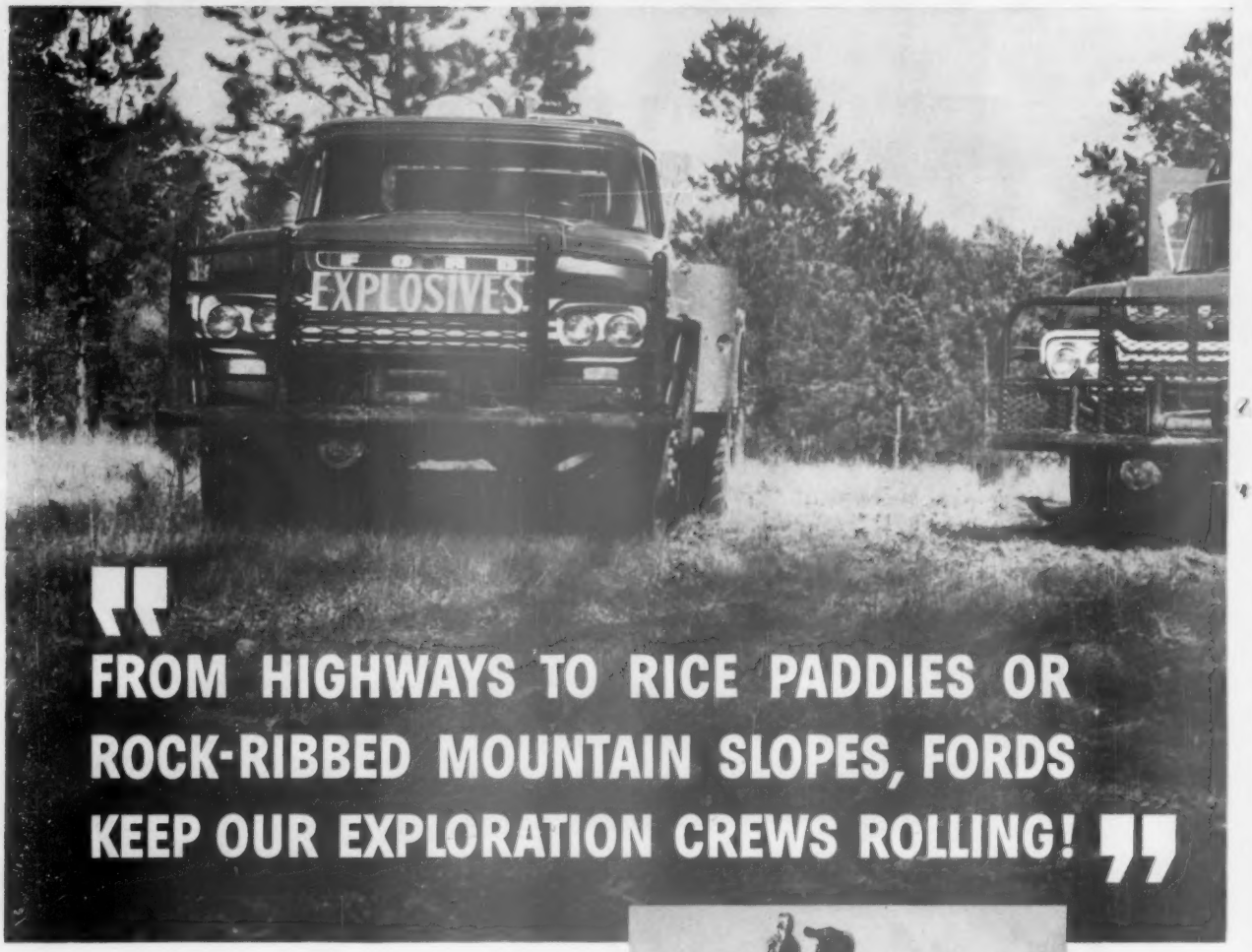

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Surveying with radar, this GSI surveyor uses a "Tellurometer" mounted on a special platform over the Ford F-250's cab. This new electronic, line-of-sight device is used for long survey traverses for seismic operations in West Texas and similar areas of the world. Elevated above the brush, a 10- to 15-mile line can be accurately surveyed from a single setup.

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America's lowest-priced* pickup truck!

The Falcon Ranchero is priced lower than any pickup in America with comparable standard equipment! And that is just the beginning of your savings. Single-unit construction saves on maintenance . . . it's tighter, quieter, with main underbody structural members zinc-coated against rust and corrosion. Front fenders bolt on, cost less to replace. And Ranchero's passenger-car ride and handling ease lessen driver fatigue.

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BIG 6-FOOT BOX!

Capacity is more than ample for most pickup hauls—nearly 8 feet of load length with tailgate flat. And thanks to the low floor height, loading and unloading is faster, easier!

FEATURES:

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7. Styled to capture admiration

*Based on a comparison of latest available manufacturers' suggested retail delivered prices with comparable standard equipment

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per bbl., 59.7°, shut-in TP 3,940 psi., perf. 7,830-40 ft., Frio. TD 8,603 ft. Discovery well of East Santa Fe field.

Jim Hogg County:

Sun Oil Co. 60 A. C. Jones, Agua Nueva de Abajo Grant, A-258, 29 miles northeast of Rio Grande City. AOF 5 M.M.c.f.d.., GLR 33,821 cu. ft. per bbl., 50.7°, shut-in TP 2,467 psi., perf. 6,051-55 ft., Yegua. TD 6,200 ft. New pay in Jones field.

Milam County:

General Crude Oil Co. 2 Perry, D. H. Vanveighton Sur., A-373, 10 miles southeast of Rockdale. IPP 22 BOPD, 36°, perf. 3,475-95 ft. and 3,498-3,506 ft., Navarro. TD 8,614 ft. New-field discovery.

Starr County:

Humble Oil & Refining Co. 1-B Arcadio Guerra, Share 6, San Jose Grant, 4 miles southeast of San Ysidro. AOF 1,600 M.c.f.d., GLR 70.9 M.c.f. per bbl., 70.8°, shut-in TP 1,335 psi., perf. 5,631-36 ft., Frio. TD 6,500 ft. Extension and new pay in South Jay Simmons field.

Webb County:

Texaco Inc. 4 A. M. Bruni, Section 1572, Rafael Sciaraffa Sur., A-2446, 4 miles west of Aguilares. IPP 50 BOPD (net), 43% water, 17°, perf. 1,214-19 ft., Yegua. TD 1,350 ft. New pay in Presa de Oro field.

Acknowledgement...

The type log of the shelf facies of Hugoton-Panhandle region which appeared on p. 149, The Oil and Gas Journal, April 25, was through the courtesy of the Liberal Geological Society, Liberal, Kans. Credit line was inadvertantly omitted.

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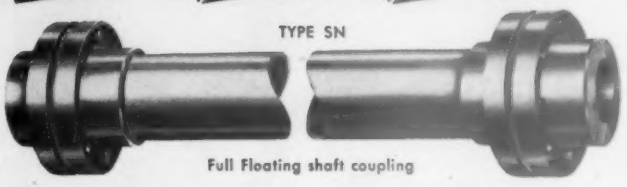

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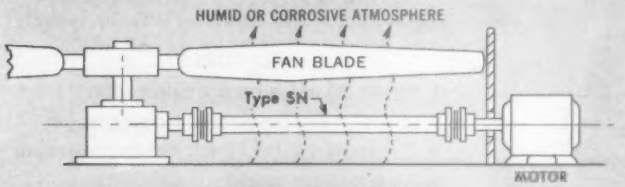

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TEXAS GULF COAST

Colorado County:

Appell Petroleum Corp. 1 C. Labaj Unit, Sam Kennelly League, A-30, 3½ miles north of Garwood. AOF 10 M.M.c.f.d., GRL 63,090 cu. ft. per bbl., 62.7°, Shut-in TP 2,242 psi., perf. 6,812-18 ft. TD 6,862 ft. New pay in Englehart field.

Grimes County:

Texaco Inc. 1 R. P. Trant, BBB&C Sur., A-124, 7½ miles northwest of Piedmont. AOF 3,230 M.c.f.d., dry gas, shut-in TP 745 psi., perf. 1,726-32 ft., Queen City. TD 3,759 ft. Discovery well of Ferguson Crossing (proposed) field.

Jasper County:

Atlantic Refining Co. 1-C J. H. Kurth, George Johnson Sur. 44, 6 miles east of Evadale. IP 23.83 BOPD, 12/64-in., 45.8°, TP 400 psi., GOR 12.2 M.c.f. per bbl., perf. 8,573-82 ft. TD 9,210 ft. Discovery well Bunker Hill (proposed) field.

Lavaca County:

Socony Mobil Oil Co., Inc., 1 Sylvia W. Kahanek, James Kerr Sur., A-24, 6 miles southwest of Halletsville. AOF 3,600 M.c.f.d., GLR 70.4 M.c.f. per bbl., 52.2°, shut-in TP 3,822 psi., perf. 13,320-14,278 ft., Edwards lime, TD 14,361 ft. New deep pay in Word Wilcox field.

San Patricio County:

Engeo Oil & Gas Co. 1 R. H. Welder Estate, Section 47, Eliza H. Welder Subd., 8 miles north of Taft. IP 129 BOPD, P-47 choke, 20°, TP 250 psi., GOR 420 cu. ft. per bbl., perf. 5,426-34 ft., Frio. TD 7,015 ft. New-reservoir discovery in Plymouth area.

H. H. Howell and George A. Musselman 2 Paul A. Musselman, Section 56, IRR Co. Sur., A-318, 13 miles northeast of Victoria. AOF 17 M.M.c.f.d., dry gas, shut-in TP 1,546 psi., perf. 3,748-50 ft., Frio. TD 3,990 ft. New pay in Salem field.

TEXAS PANHANDLE

Ochiltree County:

Stekoll Petroleum Corp. 1-16 Cavins-Jarvis, Sec. 16, E. C. Hooper Survey, 15 miles south of Waka, 3 miles southwest of Wamble Upper Morrow gas field. IPCAOF 18 M.M.c.f.d., SIP 1,856 psi., Upper Morrow sand 8,174-84 ft. TD 9,123 ft. Gas discovery.

WEST CENTRAL TEXAS

Jones County:

Geochemical Surveys 1 D. G. Strole, 4.7 miles north of Hamby in Sec. 43, Blk. 14, T&P Sur. IPP 60 BOPD, 41°, Cook sand 1,778-80 ft. TD 3,455 ft. New oil discovery.

NEW MEXICO

Rio Arriba County:

Intex Oil Co. 1 USL-Alto, C NW NE 5-26n-1e. IPP 130 BOPD, Niobrara discovery, new field. TD 1,958 ft. Niobrara pay 1,927-58 ft.

Heralding

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April 21, 1960

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STEIN JOHNSON KINNEY THOMAS

Champlin Vice Presidents Move Up

CHAMPLIN Oil & Refining Co. has elected an executive vice president, four senior vice presidents, and a new vice president.

J. L. Rune, senior vice president and a director of the company, has been elevated to executive vice president. Named senior vice presidents were Ira H. Stein, Charles B. Johnson, Jr., J. P. Kinney, and Ray Thomas. Ed Hardin, general sales manager, has been named vice president in charge of sales.

Stein, land and exploration vice president since 1954, will be senior vice president in charge of land, geology, production, and petroleum engineering. Johnson will be senior vice president in charge of natural gas operations, pipelines, and manufacturing. He had been vice president, natural gas operations and pipelines. Kinney, financial vice president, will

RUNE

HARDIN

be senior vice president, financial. Thomas, marketing vice president, will be senior vice president in charge of this division.

Rune, Stein, Johnson, and Hardin were with Chicago Corp. before its purchase of Champlin Refining Co. in 1954. Thomas joined Champlin, the subsidiary company, in 1954. Champlin and Chicago Corp., were merged into Champlin Oil & Refining in 1956.

J. D. Gray, tool pusher with Falcon Seaboard Drilling Co., has been transferred to Denison, Tex., from Purcell, Okla.

Hugh D. McFaddin, shareholder representative for Standard Oil Co. (N. J.) affiliates in Scandanavia, has retired after 37 years with Jersey companies.

J. T. Taylor, district engineer in Purcell, Okla., for Humble Oil & Refining Co.'s Carter Division, has been named assistant area engineer in the Carter Division's Oklahoma City office. **W. B. Weaver** will succeed Taylor in Purcell, **R. L. Shaw** has been named district engineer in St. Elmo, Ill. He succeeds **D. E. Shupp,** who is on temporary assignment in Carter Division's Tulsa headquarters. **S. E. Barker,** district engineer in Billings, Mont., has been named assistant district superintendent in Magnolia, Ark. **G. J. Lookabaugh** will succeed Barker. **H. K. Quattlebaum,** district engineer in Carmi, Ill., has been named assistant area engineer in Mattoon, Ill. **E. G. Weaver,** Jackson, Miss., district engineer, will succeed Quattlebaum. **R. H. Williams** will succeed Weaver.

Bert Arnold, tool pusher for Helmerich & Payne, Inc., has been transferred to Liberal, Kans., from Glendive, Mont.

Larry W. Cheeves has been named research and economics analyst for the marketing department of DX Sunray Oil Co.

James L. Foster, technical representative, market development (polyethylene), for Goodrich-Gulf Chemicals, Inc., has been appointed manager of polyethylene sales.

R. E. Hurst, district engineer in the Permian Basin area for Dowell Division of Dow Chemical Co., has been named district technical manager, a new position. Hurst has been with the company since 1949.

Herbert D. Thornton has been appointed production manager, natural resources, for Union Carbide Olefins Co., division of Union Carbide Corp. He will be responsible for natural-gas exploration and development. Thornton has been purchasing agent in Union Carbide's petroleum division, general purchasing department.

▶▶▶ Personals

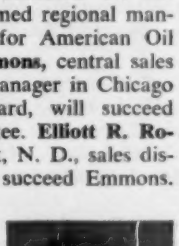
F. E. O'Brien, geologist with Ohio Oil Co., has been transferred to Chickasha, Okla., from Ardmore, Okla.

James Stark, field party chief with Phillips Petroleum Co., has been transferred to Grand Junction, Colo., from Elk City, Okla.

Marlin E. Sandlin, executive vice president of Woodley Petroleum Co. before its merger with Pure Oil Co., has been elected chairman of Pan American Sulphur Co. He succeeds **J. R. Parten.** Sandlin also will be general counsel for Pan American Sulphur and a consultant to Pure.

John A. Storm, assistant sales director for Sinclair Oil & Gas Co., has moved up to sales director. He succeeds **A. T. (Fons) Scherer,** who has retired. Scherer will continue as a consultant to Sinclair. **W. R. Raney** will succeed Storm. Storm has been with Sinclair since 1940. He is a director of Sinclair Petrochemicals, Inc.

Guy D. Carroll, northern sales region manager for Standard Oil Co. (Ind.), has been named regional manager in Baltimore for American Oil Co. **Robert F. Emmons,** central sales region marketing manager in Chicago for Indiana Standard, will succeed Carroll in Milwaukee. **Elliott R. Rosenberger,** Bismarck, N. D., sales district manager, will succeed Emmons.



REID

James C. Reid, executive vice president of Southern Union Gas Co., has been elected president of the company. He succeeds **C. H. Zachry,** who has retired. Zachry will continue as a director. **Scott Hughes,** first vice president, will succeed Reid as executive vice president. **N. P. Chesnutt,** chief engineer, has been named vice president and operating manager.

Robert L. Folk, associate professor of geology, University of Texas, received the President's Award of American Association of Petroleum Geologists at the association's annual meeting last week. The award is given to the author, under age 35, writing the most significant article on petroleum geology in the association's Bulletin in the preceding year.

PEW

THAYER

WRIGHT

HORROCKS

KIRKBRIDE

SCHROEDER

Six Executives Promoted in Sun Management Realignment

THREE senior vice presidents have been named by Sun Oil Co. and three additional vice presidents have been elected in an expansion of the company's top management positions.

Senior vice presidents are Jno. G. Pew, Clarence H. Thayer, and Willard W. Wright. Pew has been vice president in charge of production; Thayer, vice president in charge of manufacturing and research and engineering; and Wright, vice president in charge of marketing.

New vice presidents include Thomas S. Horrocks, general sales manager, named vice president in charge of marketing activities; Chalmer G. Kirkbride, executive director of research and engineering, now vice president in charge of research and engineering; and Kingsley V. Schroeder, director of production, now vice president in charge of domestic and Canadian production activities.

Senior vice presidents will be concerned mainly with policy and planning activities in the new setup. Pew will work with production planning, including crude-oil purchases and sales; Thayer with manufacturing, and research and engineering departments; and Wright with marketing. Thayer will temporarily assume responsibilities held by Frank R. Markley, vice president in charge of transportation, who has retired. Also, Wright will take over some administrative functions outside the marketing department.

Operation of major company divisions will be handled by four vice presidents—Horrocks, Kirkbride, Schroeder, and Wilburn T. Askew, who was elected vice president in charge of refineries a few months ago.

Sun also has elected William S. Woods, Jr., as a second assistant secretary and treasurer. He has been manager of the financial and stock division, treasury department.

F. Kent Eby, engineer with British-American Oil Producing Co. in Riverton, Wyo., has joined Mack Oil Co. in Duncan, Okla., as engineer.

C. R. Potter has been promoted to shift foreman, light oils division, at the Casper, Wyo., refinery of Standard Oil Co. (Ind.). He succeeds **Leo Mitchell,** who has retired.

Dudley Tower, senior vice president of Union Oil Co., has been elected executive vice president. **John W. Towler,** director of manufacturing, and **N. T. Ugrin,** director of industrial relations, have been elected vice presidents of the company.

W. D. Dobbins has joined Delhi-Taylor Oil Corp. as district geologist in McAllen, Tex. He was formerly with Forest Oil Corp. in Corpus Christi, Tex. **Carl F. McClellan,** area landman for the South Texas and Gulf Coast areas in Dallas, has been promoted to district land man in McAllen.

Martin Russo, Sun Oil Co.'s district geologist in McAllen, Tex., has been named regional geologist for Sun's southwest production division in Dallas. He succeeds **Charles H. Row,** who will retire June 1 after 38 years with the company. **Robert Layden,** assistant district geologist in McAllen, will succeed Russo there.

Harold V. Heffner, retail sales supervisor in Tidewater Oil Co.'s division marketing office, Los Angeles, has been named assistant retail marketing manager for the western division.

Thomas E. Neudecker, exploration geologist for Felmont Oil Corp. in Owensboro, Ky., has joined Pohly Exploration Co., Tulsa, as chief geophysicist. Neudecker was with W. C. McBride, Inc., before joining Felmont.

Herman G. Gunter, assistant refinery manager for Commonwealth Oil Refining Co., Inc., has been elected vice president and general manager of refinery operations. Gunter had been with Standard Oil (N. J.), Suntide Refining Co., and Continental Oil Co. before joining Commonwealth last year.

Sohio Petroleum Co. has eliminated its Gulf Coast division office in Houston and district activities have been consolidated in a new Gulf Coast area exploration office in Houston. **Dwight H. Seely, Jr.,** recently was named exploration manager in charge of the new Gulf Coast area office. In other appointments, **James H. Morris,** Lafayette, La., district exploration superintendent, has been named area geologist for Texas and offshore. **Robert J. Field,** staff assistant to the division exploration manager, has been named area geologist for south Louisiana. **T. C. Danie** will be district geologist for south Texas, with **W. L. Rader** as senior geologist for offshore, Louisiana, and Texas. **A. J. Napier,** Lafayette district geologist, has been named district geologist for south Louisiana. **C. E. Storm,** assistant division land man, has been named Gulf Coast area land man. **S. A. Hatcher,** New Orleans district geophysicist, has been appointed area geophysicist. **Jon Brook** will continue as district land man in Lafayette and **L. L. Fergus** will continue as New Orleans district land man. **C. F. Wendenburg** will remain in charge of geophysical shop and field seismic crews. **S. W. Estes,** staff assistant, will be assistant to Seely in administrative matters.

R. L. Minckler, senior vice president of Mobil Oil Co., has been elected to a 3-year term as senior board member of the National Industrial Conference Board. He is also a Conference Board trustee. **E. L. Steiniger,** president of Sinclair Oil Corp.; **Herbert Willetts,** executive vice president of Socony Mobil Oil Co.; and **George S. Young,** president, Columbia Gas System, Inc., have been named to 1-year terms as board members.

▶▶▶ Personals

C. L. Love, exploration geologist for Standard Oil Co. of California in Salt Lake City, has been transferred to Coalinga, Calif., as reservoir engineer.

H. J. Caine has been transferred by Superior Oil Co. from Albuquerque to Midland, Tex., where he will be district geologist.

J. Douglas Stahl, production engineer with Cities Service Oil Co., has been transferred to El Dorado, Kans., from Olney, Ill.

B. R. Noel, drilling superintendent with American Petrofina Co. of Texas, will be president of Triad Drilling Co., Inc., new company organized in Jackson, Miss. **Dudley J. Hughes** and **Carroll G. Jones** are Triad Drilling vice presidents. Hughes was district geologist, southeastern states, for Petrofina in Jackson. Jones was Petrofina district land man for the southeastern states.

James A. Wilson, a vice president of United Gas Corp., has been elected president of the Southern Gas Association. He succeeds **Oliver W. Clark,** Southern Natural Gas Co. Other officers are **H. A. Eddins,** Oklahoma Natural Gas Co., first vice president; **C. L. Nairne,** New Orleans Public Service Co., Inc., second vice president; **Willard G. Wiegel,** Lone Star Gas Co., treasurer; **Frank Barragan, Jr.,** South Atlantic Gas Co., secretary; **Minor C. Sumners,** Mississippi Valley Gas Co., chairman of the advisory council; and **W. C. McGee, Jr.,** Tennessee Gas Pipeline Co., vice chairman. New association directors include **Kenneth R. Teele,** Mobil Gas Service Corp.; **M. V. Burlingame,** Natural Gas Pipeline Co. of America; **A. B. Paterson,** Louisiana Gas Service Co.; **L. O. Vogelsang,** Rio Grande Valley Gas Co.; **Dwight B. Sprow,** Natural Gas Pipeline Co. of America; **Carrington Mason,** Houston Natural Gas Corp.; and **Van F. Leach,** Atlanta.

WILSON

R. N. Blaize has been named vice president for Signal Oil & Gas Co.'s Houston division. The division recently was set up with properties of Eastern States Petroleum & Chemical Corp. Blaize was president of Eastern States before its merger with Signal in September. He is also a director of Signal.

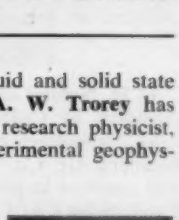
Officers Named by API Rocky Mountain District

ELECTED chairman of API's Rocky Mountain district, Division of Production, was Larry Powell, first row, center, Ohio Oil Co., Casper, Wyo. Powell succeeded Ralph W. Collins, first row, left, Midwest Oil Corp., Denver, at the group's recent annual meeting in Casper. Collins and Fred W. Kumpf, production supervisor for Mobil Oil Co. in Casper, received API citations for service at the meeting. Other new district officers include, Jack Lucey, first row, right, Oil Well Supply Co., Casper, secretary-treasurer; and vice chairmen, second row, left to right, Clayton Johnson, Equity Oil Co., Salt Lake City, for Utah, F. H. Egolf, Phillips Petroleum Co., Casper, for Wyoming; J. V. Boxell, Calvert Drilling Co., Bismarck, for North Dakota; and E. A. Davenport, Shell Oil Co., Billings, for Montana. Not pictured are Claude Peavy, Britalta Petroleum, Ltd., Calgary, vice chairman for Canada; John Tynan, Continental Oil Co., Denver, vice chairman for Colorado; and W. F. Rogers, Rogers Oil Co., Scottsbluff, vice chairman for Nebraska.

John S. Freeman, Tulsa, former president of Skelly Oil Co., has been elected a director of Columbian Carbon Co.

Robert L. Knox, staff engineer for Sohio Petroleum Co. in Oklahoma City, has been transferred to Russell, Kans., as assistant foreman.

Newly appointed senior research chemists at California Research Corp.'s Richmond, Calif., laboratory include **Dr. T. R. Hughes,** petroleum process research section; **Dr. F. C. Goodrich** and **Dr. E. Clippinger,** chemicals exploratory research section; **Dr. B. J. Fontana** and **Dr. W. L. Richardson,** petroleum products research section. Also at Richmond, **Dr. J. R. Thomas** has been named research scientist; **W. K. Seifert** has been named research chemist; and **R. J. Mitchell** has been appointed group supervisor in refinery technical service. At the La Habra, Calif., Cal Research laboratory, **Dr. F. F. Sabins** has been appointed senior research geologist, sedimentary petrology. **Dr. D. O. Seevers** has been named senior research associate, fluid and solid state physics, and **Dr. A. W. Trorey** has been named senior research physicist, theoretical and experimental geophysics.



REINHARDT

Kenneth W. Reinhardt, manager of Mobil Oil Co.'s manufacturing employe relations since 1956, has been named manager of the company's Trenton, Mich., refinery. He succeeds **Thomas S. Lennox,** who will retire June 1 after 30 years with the company. **Russell B. Tompkins,** project supervisor in Socony Mobil Oil Co.'s employe relations department, will succeed Reinhardt. Reinhardt joined the company in 1938 as a refinery engineer.

Harold S. Winston has joined Neville G. Penrose, Inc., in Midland, Tex., as petroleum engineer. He had been with Gulf Oil Corp.

Personals

K. W. Brill has been promoted to vice president and general manager of Continental Oil Co.'s Rocky Mountain region. He succeeds **J. W. Liddell,** who has retired after 36 years with the company. Brill has been a Conoco vice president since 1958. He was named assistant general manager of the Rocky Mountain division earlier this year. He will be succeeded in this post by **E. L. Shafer,** vice president and production manager for Hudson's Bay Oil & Gas Co., Ltd., an affiliate. **D. R. Johnson,** Houston, has been elected a vice president of Conoco. Johnson will continue as general manager of the manufacturing department. He has served the company as superintendent of the Ponca City, Okla., refinery and southern region refinery manager. Continental also has promoted **C. K. Shepherd,** manager of acquisitions in the foreign department, to general manager of the central region in Oklahoma City. Shepherd succeeds **Hal F. Nabors,** who recently was transferred to New York as manager of production in the foreign department. Shepherd is a former president of Sahara Petroleum Co., a Conoco subsidiary.

BRILL

L. H. Nuland has been named vice president of California Texas Oil Corp., subsidiary of Texaco Inc. and Standard Oil Co. of California. He will continue as president of Mid-East Crude Sales Co., Ltd., an affiliate.

Jack Balderas, geologist with Gulf Oil Corp., has been transferred to Bismarck, N. D., from Denver.

Edman R. Zink, exploration geologist for Standard Oil Co. of Texas, has resigned to open consulting offices in San Antonio, Tex.

Robert L. Egbert and **Forest E. Nelson,** geologists for Phillips Petroleum Co., have been transferred to Denver from Billings, Mont.

Jack M. Dennis, petroleum engineer with Texaco Inc., has been transferred to Dallas from Wichita Falls, Tex.

Gerald D. Brown has resigned as geologist with Pure Oil Co. in Oklahoma City to join Youngblood & Youngblood, Oklahoma City producing firm. Brown was with Seismograph Service Corp. before joining Pure.

Ford H. Blunck, planning division manager in the manufacturing department of Standard Oil Co. (Ind.), has been appointed coordinator of foreign operations for the company, a new position. Blunck's responsibilities will cover all foreign operations of Indiana Standard and its affiliates, other than those engaged in exploration and production. Blunck has been with Indiana Standard since 1936. He was general superintendent of the Wood River, Ill., refinery before moving to Chicago as planning division manager in 1956.

David A. Roach, vice president of Phillips Pipe Line Co. in Bartlesville, Okla., has joined the new Mid-America Pipeline Co. as vice president. He will headquarter in Tulsa. Mid-America is building a LPG line from Texas and New Mexico to Wisconsin. The company, backed by Missouri-Kansas-Texas Lines, is one of the few pipeline ventures by a railroad. Roach had been chief engineer for Phillips Pipe Line before being named a vice president of that company.

Jack E. Stoffregen has been named superintendent of Peoples Gulf Coast Natural Gas Pipeline Co.'s Biggers, Ark., compressor station. He succeeds **J. R. Buffington,** who has taken a leave of absence because of illness. Stoffregen had been superintendent of the Pampa, Tex., booster station of Natural Gas Pipeline Co. of America, an affiliate. **James R. Ivey,** special engineer in Chicago, will succeed Stoffregen in Pampa.

Frank G. Scott II has been named assistant superintendent of the gas control department for Transcontinental Gas Pipe Line Corp. in Houston. Scott has been with the company since 1951.

Hallan N. Marsh, manager of the production and equipment section in Mobil Oil Co.'s California division, has retired after 37 years with Mobil and its affiliates. Marsh invented the Marsh Funnel, mud measuring device, and holds several patents in the oil-equipment field.

Deaths

Oliver C. Whitling, 86, retired superintendent of the Minnehoma Oil Co., died April 25 in a Tulsa hospital after a long illness. Whitling retired in 1941. He had been assistant superintendent for Pure Oil Co. in Okmulgee, Okla., before joining Minnehoma in Tulsa.

Robert Gray Whitton, 55, production foreman for Union Producing Co. in Houma, La., died April 18.

Francis J. Curtis, 65, retired vice president for personnel and former director of Monsanto Chemical Co., died April 21 in a St. Louis hospital. Curtis retired last year after 44 years with Monsanto. He had been director of development before being named a vice president and secretary of Monsanto's executive and finance committees in 1943. He was elected a director in 1949. Curtis was a past president of Society of Chemical Industry and of American Institute of Chemical Engineers. He received AIChE's 1959 Founders Award and Commercial Chemical Development Association's honor award in 1951 for contributions to chemical development and engineering.

John Dunlap Jones, 84, California pioneer and former superintendent of the old Monte Cristo Oil Co. in Oildale, Calif., died April 21 in Huntington Park, Calif.

John E. Klein, 80, retired general manager of the southern pipeline district of Standard Oil Co. of California in La Mirada, Calif., died April 16 at his home in Los Angeles. Klein was with Standard of California 40 years before retiring in 1945.

Lowell Taylor, 54, assstant superintendent of Warren Petroleum Corp.'s Ringwood, Okla., natural-gasoline plant, died April 22 at his home in Ringwood.

Bruce Ramsey, 65, retired vice president and general manager and a director of Interstate Oil Pipe Line Co., died April 27 in Wilcox, Ariz., after a heart attack. Ramsey retired in 1955.

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General oil field contractor says:

"BANTAM gets in there and digs where going is hard"

"Fast and smooth . . . economical to run . . . doesn't give me any trouble"—good reasons why owner S. C. Hawthorne of the Hawthorne Oilfield Const. Co., Beaumont, Texas, bought his second BANTAM C-350 just two weeks after the first!

BANTAM's big-rig features and exclusive engineering advantages enable Hawthorne to get in and dig where the going is rough—and to do the job better, faster and at a lower cost than with any other rig in its class. With a dragline bucket, BANTAM digs and backfills drilling mud pits and ditches; and BANTAM loads gravel for roads, and loads and unloads drilling equipment and pipe.

Increased capacity, greater power, faster line speeds and added flexibility are benefits gained from whatever BANTAM you choose. With 11 quick-change attachments, your BANTAM is ready to work anywhere, at any job. For example, you can add BANTAM's long-boom back hoe for digging depths to 18′10″—greatest trenching production in its class. And more than 25 optional features let you equip your BANTAM to fit any specific job need.

Get all the facts on the entire BANTAM line; the C-350 crawler, the T-350 carrier-mounted and the CR-350 self-propelled models. See your BANTAM distributor and get the facts that will prove BANTAM's superiority in speed and savings over any other rig in its class.

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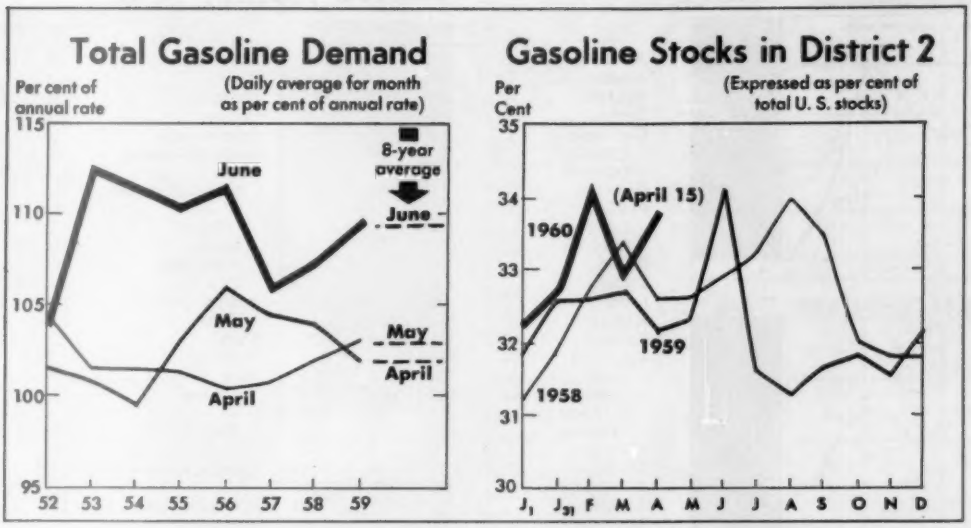


Shifting demand–high stocks–low prices

BY JOHN C. CASPER

THE SEASONAL PATTERN of gasoline demand has been shifting in recent years, and these shifts have become an important factor behind unstable gasoline markets.

Variations from the old marketing schedules in combination with excessive gasoline stocks have resulted in low-priced gasoline for several summers.

Here is how it works. An unexpected increase in gasoline demand creates little pressure for higher prices because stocks are high. But, if demand for a given month falls below the expected level, there is a good chance that some supplier will push the panic button and start a price skid that ends with gasoline selling below cost.

Suppliers and distributors tend to follow a marketing pattern, based on past operations. But, statistics for the postwar years show a definite change in gasoline demand by seasons and by months.

The chart at left above shows total gasoline demand for April, May, and June. Demand for the month is expressed as a per cent of the annual demand rate. For example, gasoline demand for April 1956 is plotted as 1.003 since total gasoline demand that month was 3,861,000 bbl. daily or 0.3% above the year's average of 3,849,000 bbl. daily.

Note on the chart that the April line has been rising since 1956 and that the May line has been dropping steadily. Gasoline demand for May 1956 was 6.0% above the average for the year. Last year it was only 2.0% above.

The chart also shows that demand for gasoline in June is tough to forecast. June demand in 1956 was 12% above the average for the year. The spread was down to 6% in 1957.

The small bars at the right of the chart give the 8-year average position for each of the three early-season months.

Refiners have still another problem this year. Most of the increase in gasoline stocks has been in District 2. The chart on the right pictures District 2 gasoline inventories as per cent of total gasoline stocks.

For the past 3 years, District 2 gasoline has climbed to a peak earlier each year. In 1958, District 2 stocks topped 34% of total gasoline inventories by the end of August. Last year, the peak was 34.1% of the total and had moved up to the end of June. This year, stocks in the district accounted for 34.4% of all gasoline in the country at the end of February.

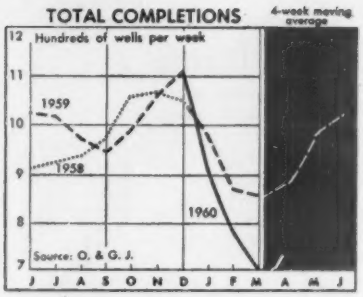
District 2 gasoline stocks increased 17,200,000 bbl. during the first quarter of this year. The net gain was at least 5,000,000 bbl. more than was needed to balance supply and demand during the motoring season.

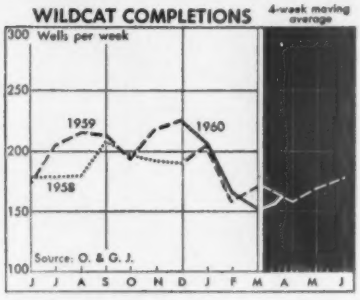
If refiners expect to make any money on gasoline, they will have to find a better crystal ball or learn to live with surplus inventories without panic.

A quick look at the highlights . . .

	LATEST WEEK	Change from WEEK AGO		Change from YEAR AGO	
Production	7,000,795	DOWN	39,690	DOWN	261,775
Crude stocks	258,925,000	UP	2,752,000	UP	7,922,000
Completions	723	DOWN	90	DOWN	155
Refinery runs	7,967,000	UP	69,000	UP	262,000
Gasoline stocks	221,552,000	DOWN	3,245,000	UP	9,805,000
Kerosine stocks	19,113,000	UP	260,000	DOWN	1,526,000
Distillate stocks	78,408,000	UP	2,030,000	DOWN	3,079,000
Residual stocks	38,813,000	DOWN	278,000	DOWN	16,677,000
Four-product stocks	357,886,000	DOWN	1,233,000	DOWN	11,477,000
Total imports	2,008,400	UP	112,700	UP	835,800

DRILLING





Active Rotary Rigs

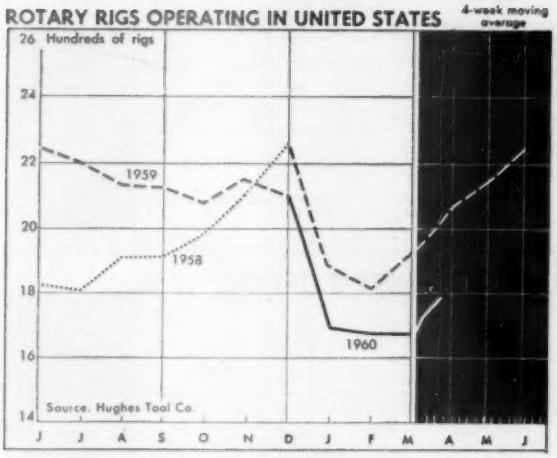
	4-25-60	4-18-60	4-27-59
Alabama	3	3	7
Alaska	5	5	(†)
Arkansas	14	10	15
Arizona	2	4	0
California	94	91	95
Land	88	86	92
Offshore	6	5	3
Colorado	30	23	28
Florida	2	2	2
Land	1	1	1
Offshore	1	1	1
Illinois	48	45	41
Indiana	6	4	13
Iowa	0	0	3
Kansas	134	129	143
Kentucky	4	8	9
Louisiana	286	303	349
North	34	41	35
S. Inland waters	118	105	152
S. Land	75	99	118
Offshore	59	58	44
Maryland	0	0	0
Michigan	13	20	21
Mississippi	73	73	56
Missouri	1	1	0
Montana	17	12	22
Nebraska	19	29	29
Nevada	0	0	0
New Mexico	117	115	113
New York	1	1	1
North Dakota	18	18	41
Ohio	5	4	2
Oklahoma	191	207	233
Oregon	0	0	0
Pennsylvania	12	11	11
South Dakota	0	1	2
Texas	620	620	770
S. Inland waters	10	10	6
S. Land	153	165	176
Offshore	2	1	1
North	43	44	160
Panhandle	55	52	(*)
East	62	63	(*)
West Central	187	185	272
West	108	100	155
Utah	25	30	31
Washington	0	0	0
West Virginia	4	5	6
Wyoming	52	55	65
Total U. S.	1,796	1,829	2,108
Western Canada	91	99	127
Eastern Canada	2	2	0
Grand Total	1,889	1,930	2,235

Hughes Tool Co. report. *Included in North. Comparisons not available due to change in method of reporting. †Data first reported 4-4-60.

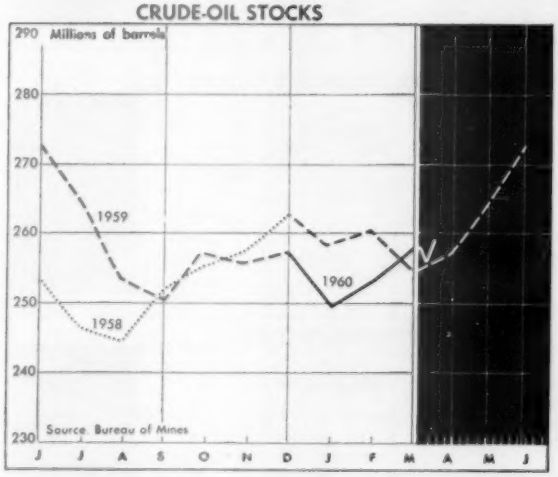
WEEKLY WELL COMPLETIONS . . . WEEK ENDED APRIL 23, 1960

	Total wells							Cum.		Total wildcats					Cum.	
	Total	Crude	Cond.	Gas	Dry	Service	Footage	1960	1959	Total	Crude	Cond.	Gas	Dry	1960	1959
Alabama	2	2	0	0	0	0	23,016	17	35	0	0	0	0	0	1	5
Arizona	0	0	0	0	0	0	0	6	.....	0	0	0	0	0	6	.....
Arkansas	24	9	0	2	11	2	81,216	187	275	7	1	0	0	6	48	48
California	23	14	0	1	8	0	116,146	400	466	6	0	0	0	6	88	111
Colorado	11	3	1	2	5	0	45,122	217	227	8	3	0	1	4	103	135
Illinois	17	8	0	0	8	1	36,596	596	635	4	0	0	0	4	155	108
Indiana	20	8	0	1	11	0	31,179	269	198	9	2	0	0	7	115	69
Kansas	47	24	0	3	20	0	161,302	948	1,255	15	1	0	0	14	318	288
Kentucky	8	3	0	0	5	0	9,590	530	503	0	0	0	0	0	63	51
Louisiana	59	19	6	5	29	0	465,467	1,003	1,092	13	1	0	0	12	156	139
North	27	5	0	5	17	0	130,441	322	381	7	0	0	0	7	65	61
South	23	10	5	0	8	0	235,530	510	590	5	1	0	0	4	80	74
Offshore	9	4	1	0	4	0	99,496	171	121	1	0	0	0	1	11	4
Michigan	11	8	0	0	3	0	41,494	219	162	3	0	0	0	3	70	47
Mississippi	18	11	1	0	6	0	161,832	252	210	6	2	0	0	4	82	99
Montana	3	1	0	0	2	0	10,220	76	81	2	0	0	0	2	37	33
Nebraska	15	5	0	0	10	0	81,988	239	232	3	0	0	0	3	92	108
New Mexico	29	18	1	2	8	0	124,844	569	550	6	1	0	0	5	82	56
West	10	3	1	2	4	0	35,146	192	.....	2	0	0	0	2	19	.....
East	19	15	0	0	4	0	89,698	377	.....	4	1	0	0	3	63	.....
New York	0	0	0	0	0	0	0	100	97	0	0	0	0	0	7	8
North Dakota	10	7	0	0	3	0	73,141	97	140	2	0	0	0	2	17	29
Ohio	16	8	0	4	4	0	47,892	342	291	0	0	0	0	0	15	8
Oklahoma	64	25	0	6	32	1	288,512	1,149	1,847	15	2	0	2	11	212	282
Pennsylvania	0	0	0	0	0	0	0	185	163	0	0	0	0	0	7	3
South Dakota	0	0	0	0	0	0	0	14	.....	0	0	0	0	0	5	.....
Texas	302	162	20	14	99	7	1,252,629	4,966	6,014	57	5	1	9	42	1,014	1,149
Dist. 1	16	11	0	0	5	0	44,784	352	381	5	0	0	0	5	125	96
Dist. 2	12	1	4	1	6	0	90,463	211	249	3	0	1	0	2	50	76
Dist. 3	27	9	5	0	13	0	206,976	379	345	1	0	0	0	1	73	89
Dist. 4	18	2	6	1	9	0	111,490	372	376	4	0	0	0	4	106	104
East	48	36	0	0	12	0	116,222	378	351	6	0	0	0	6	75	76
Dist. 7-B	33	16	0	8	9	0	108,231	781	829	15	3	0	8	4	212	220
West	70	48	3	2	16	1	350,088	1,324	1,879	12	1	0	1	10	216	233
Dist. 9	60	28	0	1	25	6	135,193	919	1,142	10	1	0	0	9	132	216
Dist. 10	18	11	2	1	4	0	89,182	313	462	1	0	0	0	1	25	39
Utah	17	13	0	0	4	0	98,257	91	119	4	1	0	0	3	30	35
West Virginia	8	0	0	7	1	0	17,630	234	214	0	0	0	0	0	2	6
Wyoming	19	11	0	0	8	0	95,038	290	253	6	0	0	0	6	119	82
Miscellaneous	0	0	0	0	0	0	0	24	22	0	0	0	0	0	22	17
Total U. S.	723	359	29	47	277	11	3,263,111	13,020	15,081	166	19	1	12	134	2,866	2,916
Previous week	813	364	21	79	318	31	3,422,188	.....	.....	159	11	3	4	141	.....	.....
Cum. 1960	13,020	6,070	430	1,090	5,061	369	57,404,842	.....	.....	2,866	251	32	92	2,491	.....	.....
Cum. 1959	15,081	7,585	399	1,069	5,630	398	63,679,284	.....	.....	2,916	297	40	96	2,483	.....	.....
Western Canada	20	8	0	3	9	0	136,620	742	763	5	0	0	1	4	230	292

ROTARY RIGS OPERATING IN UNITED STATES



CRUDE-OIL STOCKS



CRUDE-OIL STOCKS BY STATES OF ORIGIN*

(Thousands of barrels)

	4-16-60	4-9-60	4-18-59
Pennsylvania	2,114	2,084	2,509
Other Appalachian	1,695	1,701	1,542
Illinois, Indiana, Michigan	9,343	9,537	8,217
Nebraska and North Dakota	2,598	2,583	2,366
Kansas	9,918	9,692	9,316
Oklahoma	17,394	17,421	16,892
Arkansas	2,189	2,248	1,638
Louisiana	18,743	19,548	19,117
North	3,276	3,383	3,095
South	15,467	16,165	16,022
Mississippi, Alabama, Florida	2,372	2,689	2,331
New Mexico	7,725	7,749	8,011
Texas	112,802	110,117	107,751
East Texas	8,596	8,301	8,344
West Texas	50,725	49,521	52,494
Texas Gulf	20,591	19,992	17,397
Other Texas	32,890	32,303	29,516
Wyoming	17,643	17,358	14,232
Other Rocky Mountain	9,856	9,756	8,954
California	28,870	29,120	34,470
Foreign	†15,663	14,570	13,657
Total	**258,925**	256,173	251,003

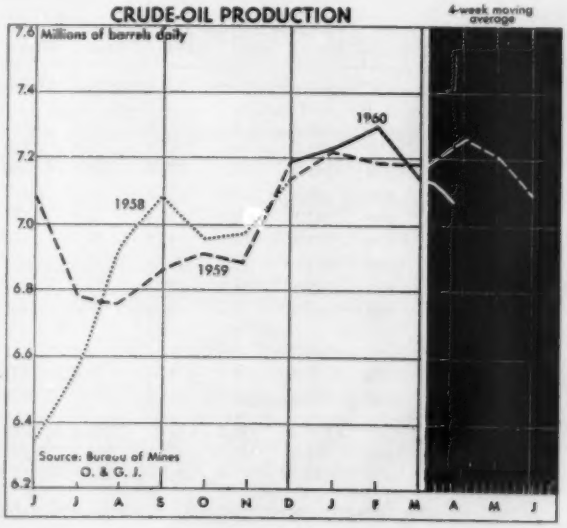
*Bureau of Mines. †Includes 4,603,000 bbl. in California.

DAILY AVERAGE PRODUCTION FOR WEEK

	April 23, 1960 Crude oil	Lease condensate	Total	Apr. 16 total
Alabama	19,300	.....	19,300	19,250
Arkansas	82,550	150	82,700	82,550
California	828,500	.....	828,500	831,000
Colorado	129,600	.....	129,600	128,900
Eastern	40,000	.....	40,000	39,300
Florida	1,100	.....	1,100	1,100
Illinois	218,100	.....	218,100	216,200
Indiana	33,000	.....	33,000	34,300
Kansas	†300,120	.....	†300,120	†325,310
Kentucky	63,700	.....	63,700	63,800
Louisiana	966,400	136,100	1,102,500	1,102,500
North	108,400	6,100	114,500	114,500
South	858,000	130,000	988,000	988,000
Michigan	32,700	.....	32,700	31,800
Mississippi	129,700	4,700	134,400	134,400
Montana	79,400	.....	79,400	79,000
Nebraska	62,300	.....	62,300	61,900
Nevada	100	.....	100	100
New Mexico	304,500	7,500	312,000	312,000
North Dakota	56,800	.....	56,800	55,200
Oklahoma	†514,900	.....	†514,900	†531,000
Texas	2,459,500	91,675	2,551,175	2,551,175
Dist. 1	41,500	3,700	45,200	45,200
Dist. 2	110,000	8,600	118,600	118,600
Dist. 3	311,000	38,000	349,000	349,000
Dist. 4	174,800	18,000	192,800	192,800
Dist. 5	27,500	500	28,000	28,000
Dist. 6	105,800	10,000	115,800	115,800
East Texas field	132,000	.....	132,000	132,000
Dist. 7-B	122,200	250	122,450	122,450
Dist. 7-C	120,100	3,225	123,325	123,325
Dist. 8	1,016,400	5,900	1,022,300	1,022,300
Dist. 9	191,200	2,400	193,600	193,600
Dist. 10	107,000	1,100	108,100	108,100
Utah	103,000	.....	103,000	110,000
Wyoming	334,000	.....	334,000	328,300
Others	‡1,400	.....	‡1,400	‡1,400
Total U. S.	6,760,670	240,125	**7,000,795**	7,040,485
Change from previous week, down			**39,690**	
Canada	†508,400	.....	†508,400	†520,000
Total U. S. production—Jan. 1-Apr. 23			817,576,500 bbl.	
Same period last year (crude plus cond.)			*815,167,200 bbl.	

*Includes 21,918,700 bbl. condensate. †Week ended previous Monday. ‡Alaska and South Dakota.

CRUDE-OIL PRODUCTION



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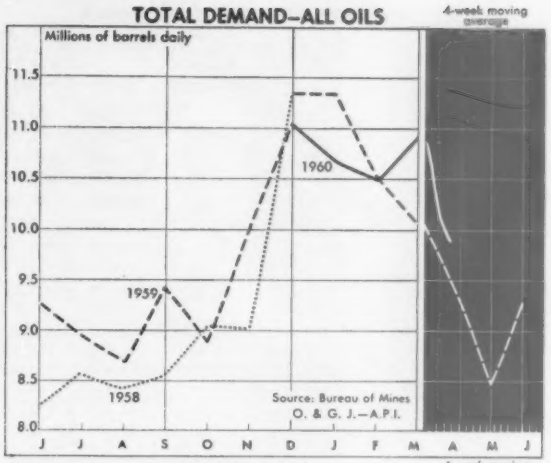

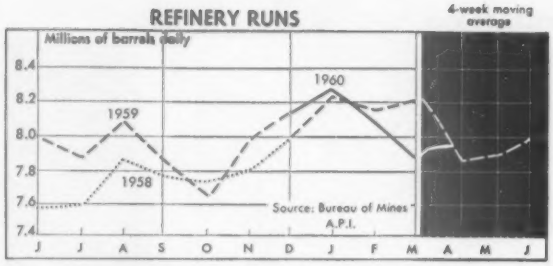

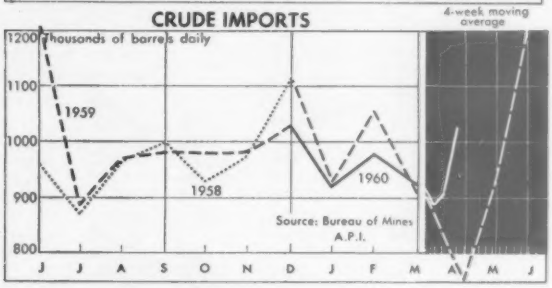

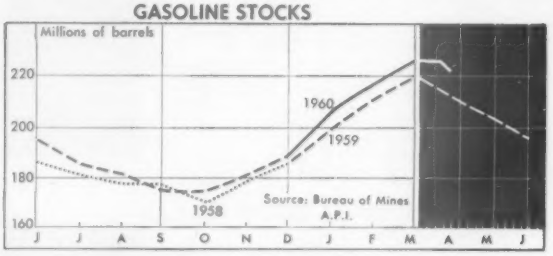

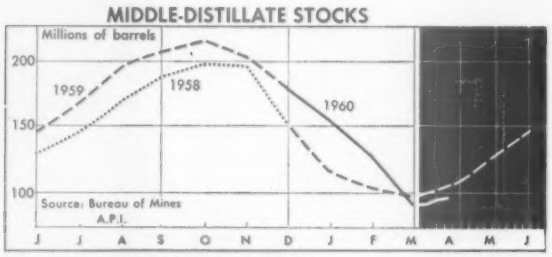

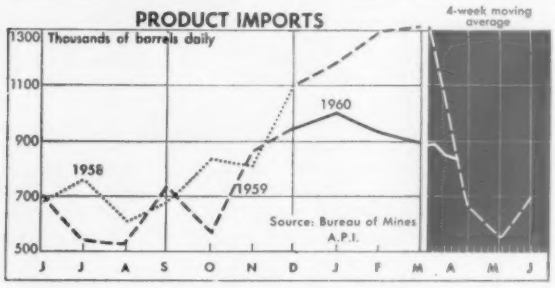

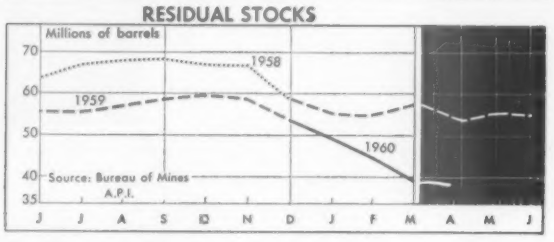

API REFINERY REPORT—APRIL 22, 1960

(Thousands of barrels)

District—	Daily avg. runs	Daily average production Gaso.*	Kero.	Dist.	Resid.	Stocks‡ Gaso.†	Kero.	Dist.	Resid.	Bureau of Mines, April 1959 Daily avg. runs	Daily average production Gaso.*	Kero.	Dist.	Resid.
East Coast	1,055	469.6	33.4	300.4	151.7	45,896	7,350	24,624	10,122	1,114	489.4	35.1	304.8	167.2
Appalachian:														
District 1	103	39.8	5.1	21.9	11.8	5,898	488	1,813	327	84	31.7	2.9	19.2	8.7
District 2	97	51.6	4.0	19.3	20.9	2,940	273	769	417	91	42.3	5.5	16.5	11.8
Ind., Ill., Ky.	1,498	745.7	71.5	313.0	168.0	42,964	3,605	12,923	3,514	1,421	723.0	68.0	286.5	156.3
Minn., Wis., Dak.	125	60.8	4.0	32.4	15.4	6,839	495	2,586	598	92	43.4	5.6	21.4	11.9
Okla., Kans., Mo.	693	347.1	20.1	150.7	16.3	21,377	873	6,940	960	698	353.5	16.1	158.9	17.5
Inland Texas	291	213.9	10.7	52.9	19.3	7,859	479	1,460	2,426	261	192.8	6.4	47.9	20.5
Tex. Gulf Coast	1,846	973.0	63.3	444.3	133.7	29,061	2,183	8,640	4,599	1,904	966.5	77.8	472.1	164.5
La. Gulf Coast	643	391.3	36.6	179.6	39.6	12,813	1,438	2,923	975	689	363.8	45.3	150.3	43.4
N. La. and Ark.	105	47.7	6.4	20.3	5.0	5,160	435	2,118	127	106	49.0	5.1	22.8	6.3
Rocky Mtn.:														
New Mexico	24	15.3	0.4	4.1	2.3	824	49	147	154	21	11.9	0.3	4.0	2.1
Other	288	123.4	1.9	62.1	32.6	7,847	219	2,464	936	251	110.1	1.6	55.9	31.5
West Coast	1,199	555.9	43.3	210.1	264.0	32,074	1,226	11,001	13,658	1,136	508.4	6.0	179.4	295.3
Apr. 22, 1960	7,967	4,035.1	300.7	1,811.1	880.6	221,552	19,113	78,408	38,813	7,868	3,885.8	275.7	1,739.7	937.0
Apr. 15, 1960	7,898	4,067.4	342.1	1,749.9	965.9	224,797	18,853	76,378	39,091	.....	.....	.....	.....	.....
Apr. 24, 1959	7,705	3,912.7	257.4	1,649.0	914.4	211,747	20,639	81,487	55,490	.....	.....	.....	.....	.....

*At refineries including natural blended. †Finished and unfinished. ‡At refineries, bulk terminals, in transit, and in pipelines.

Crude-Oil Prices

GRAVITY SCHEDULE

	Signal Hill, Calif.	Oklahoma	West Tex. (sour)	West Tex. (Inter.)	No.* Texas	Texas Refugio Light	Bayou Sale (La.)	Denver Julesburg	Wyo. (sour)
14-14.9	$1.76	....	....	....	....	....	....	....	....
15-15.9	1.84	....	....	....	....	....	....	....	$1.81
16-16.9	1.92	....	....	....	....	....	....	....	1.86
17-17.9	2.00	....	....	....	....	....	....	....	1.91
18-18.9	2.08	....	....	....	....	....	....	....	1.96
19-19.9	2.16	....	....	....	....	....	....	....	2.01
20-20.9	2.24	$2.49	$2.35	$2.61	$2.29	$2.95	$2.90	$2.58	2.06
21-21.9	2.32	2.52	2.38	2.63	2.33	2.97	2.92	2.60	2.11
22-22.9	2.39	2.55	2.41	2.65	2.37	2.99	2.94	2.62	2.16
23-23.9	2.46	2.58	2.44	2.67	2.41	3.01	2.96	2.64	2.21
24-24.9	2.53	2.61	2.47	2.69	2.45	3.03	2.98	2.66	2.26
25-25.9	2.60	2.64	2.50	2.71	2.49	3.05	3.00	2.68	2.31
26-26.9	2.67	2.67	2.53	2.73	2.53	3.07	3.02	2.70	2.36
27-27.9	2.74	2.70	2.56	2.75	2.57	3.09	3.04	2.72	2.49
28-28.9	2.81	2.73	2.59	2.77	2.61	3.11	3.06	2.74	2.54
29-29.9	2.87	2.76	2.62	2.79	2.65	3.13	3.08	2.76	2.59
30-30.9	2.93	2.79	2.65	2.81	2.69	3.15	3.10	2.78	2.63
31-31.9	3.00	2.82	2.68	2.83	2.73	3.17	3.12	2.80	2.67
32-32.9	3.06	2.85	2.71	2.85	2.77	3.19	3.14	2.82	2.71
33-33.9	3.12	2.88	2.74	2.87	2.81	3.21	3.16	2.84	2.75
34-34.9	3.17	2.91	2.77	2.89	2.85	3.23	3.18	2.86	2.79
35-35.9	3.22	2.94	2.80	2.91	2.89	3.25	3.20	2.88	2.83
36-36.9	3.27	2.97	2.83	2.93	2.93	3.27	3.22	2.90	2.87
37-37.9	3.31	2.99	2.86	2.95	2.95	3.29	3.24	2.92	2.89
38-38.9	....	3.01	2.89	2.97	2.97	3.31	3.26	2.94	2.91
39-39.9	....	3.03	2.92	2.99	2.99	3.33	3.28	2.96	2.93
40-44.9	....	3.05	2.95	3.01	3.01	3.35	3.30	2.98	2.95

*Cooke, Grayson, Montague.

Flat Prices

Louisiana:	
Sweet Lake	$3.00
Texas:	
East Texas	3.05-3.25
Conroe	3.23-3.53
Van	3.08
Pennsylvania Grade:	
★ Bradford	$4.70
★ Middle District	4.52
★ Southwest Pennsylvania	4.25
★ West Virginia	4.07
★ Buckeye Grade	4.07
Illinois Basin	**3.00**

Foreign

Middle East, Persian Gulf (cargoes f.o.b. lifting port):	
Arabian, about 34°, Ras Tanura	$1.90
Iranian, 34.0°-34.9°, Bandar Masur	1.80
Iranian, 34.0°-34.9°, Abadan	1.81
Iraq, 36.0°-36.9°, Fao	1.82
Kuwait, 31.0-31.9°, Mina-al-Ahmadi	1.67
Qatar, about 41°, Um Said	2.05
Middle East, E. Mediterranean:	
Arabian, about 35°, Sidon	2.29
Iraq, about 35°, Tripoli, Banias	2.29
Far East (cargoes, f.o.b. Lutong, Sarawak):	
Seria Light, 37°	2.57
Canada:	
Leduc-Woodbend	$2.53
Redwater (Alta.)	2.42
Smiley (Sask.)	2.18
Pembina	2.38
Venezuela:	
Cumarebo, 47°-47.9°, Tucupido	3.34
San Joaquin, 40°-40.9°, Puerto La Cruz	3.08
Oficina, 35°-35.9°, Puerto La Cruz	2.80
Tia Juana medium, 26°-26.9°, Amuay*	2.30
Quiriquire, 16.0°-16.4°, Caripito	2.10
Lagunillas heavy, flat, Las Piedras*	2.10
Bachaquero, flat, 15°-16°, Las Piedras*	1.88

Prices for all crudes of 24° or lighter vary 2 cents per degree change, up or down. All crudes heavier than 24° vary 2.5 cents per half-degree gravity change.

*Also available at La Salina at 3 cents per barrel less.

Tanker Rates (Long Ton)

(Latest reported spot fixtures)

★ Gulf-NY, dirty (ATRS −27.5%)	$1.78
Carib.-NY, dirty (ATRS −55.0%)	1.24
★ PG-UK, dirty (Scale −70.0%)	2.90
★ BSea-Japan, dirty (Scale −57.5%) (26s. 4d.)	3.68

★ Denotes change from previous week.

Refined-Product Prices

Following quotations are realistic spot prices for refined products moving interstate on Wednesday each week. They may differ from refiners' posted prices and should not be considered as postings.

Light-product prices are in cents per gallon. Residual and crude prices are dollars per barrel. Crude prices are at the well unless otherwise listed.

Gasoline*

Mid-Continent (Group 3):	
★ Regular (91 octane)	10.50-11.00
★ Premium (99 octane)	13.00-13.75
Natural gasoline (26-70)	4.5
Breckenridge	4.0
Gulf Coast (cargoes for coastwise or export movements):	
★ Regular (90 octane)	10.00-10.25
★ Regular (92 octane)	10.25-10.50
★ Premium (98 octane)	11.00-11.50
California (rack) Los Angeles):	
Regular (88 octane)	11.65-12.15
Premium (94 octane)	12.65-13.15
Premium (100 octane)	14.00-14.65
Caribbean area (cargoes):	
Regular (87 octane)	10.00
Premium (97 octane)	11.625

*Quotations are for octanes shown. Prices usually vary with octane ratings within the regular, premium, and aviation grades.

Kerosine and Distillate

Mid-Continent (Group 3):	
Kerosine 42-44	9.00-9.50
Diesel oil (58 d.i. and above)	8.75-9.25
Distillate No. 1	8.75-9.25
Distillate No. 2	7.75-8.25
Gulf Coast (cargoes):	
Kerosine 41-43	8.625-9.00
Distillate No. 2	7.625-8.00
New York Harbor (barges):	
Kerosine 41-43	9.8-10.3
Distillate No. 2	8.8- 9.3
Diesel fuel, 48-52 d.i.	9.1- 9.6
Caribbean area (cargoes):	
Distillate No. 2	8.00

Residual Fuel (Bbl.)

Mid-Continent (Group 3):	
Residual fuel (max. 1% S)	$1.70-1.80
Gulf Coast (cargoes):	
Bunker C fuel	2.10-2.25
New York Harbor (barges):	
Bunker C fuel	$2.47
Caribbean (cargoes):	
Bunker C	$2.10
California (rack):	
Bunker C fuel, Los Angeles	$2.15

★ Denotes change from previous week.

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18" AND 20" good used pipe. Very attractive prices. Contact: The Tri-State Pipe Co., Bellaire, Ohio. Telephone OR 6-1452.

320 JTS. 2⅞" Amer. Open Hole Drill Pipe—R2—Tuboscoped. Excellant Condition. 144 Jts. 3½" I. F. Drill Pipe 15:50#. Bargain priced. Don Harman Pipe & Supply. OR 7-4343, Oklahoma City, Okla.

NEW CROLOY 5 HEATER TUBES

14—	3¾"	x ⅜" wall x 44' long
63—	4"	x ⅜" wall x 26' long
10—	4"	x ⅜" wall x 32' long
50—	4"	x ½" wall x 32' long
3—	5"	x ½" wall x 42' long
42—	6"	x ½" wall x 27' to 47' long

HEAT & POWER CO., INC.
60 E. 42nd St., N. Y. 17, N. Y.

NEW EQUIPMENT FOR SALE

1—G-100 National Geared Power, Complete with 50 H.P. Type C 2 cycle Superior Gas Engine and clutch.

11—National Underpull Jacks.

OVERTON SUPPLY COMPANY

Phone 2721, Overton, Texas

—PIPE—

2,000,000 ft.	2"	3.50# to the ft.
1,000,000 ft.	3"	7.70#
1,000,000 ft.	4"	10.98#
500,000 ft.	6"	19.80#
200,000 ft.	8 5/8"	28#
400,000 ft.	10¾"	35#
75,000 ft.	12¾"	40#
10,000 ft.	16"	42#

All No. I Grade plain end and cleaned.

INDIANA-OHIO PIPE CO.
P. O. Box 5412 Shop. Sta.
Columbus 19, Ohio
Phone CL 3-5527

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BOILERS, 70,000 #/hr. & 80,000 #/hr. 450 Psi.
HORTONSPHERES, 5,000 & 10,000 bbl.
EXCHANGERS, 78 to 2,800 sq. ft.
TOWERS, 3 ft. to 7½ ft. diameter.
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CENT. PUMPS, 15 to 7,000 GPM.
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FOR SALE EQUIPMENT

1,500 FAILINGS, 5 x 6 pumps, LeRoi compressors, water trucks, pipe, trailers, complete, $17,500 cash, each. Reply Box L-829, The Oil and Gas Journal, Tulsa, Oklahoma.

FOR SALE OR LEASE: Three (3) large perforating trucks complete with 16,000' of 7/16" single conductor line. These units are ready for the field. Box L-614, The Oil and Gas Journal, Tulsa, Oklahoma.

2—McFARLAND Hydrostatic 6" pumps in first class condition. Priced to sell. FORT WORTH PIPE & SUPPLY CO. P. O. Box 2108, Fort Worth, Texas.

WELL DRILLS—CORE DRILLS. Everything for well and core drilling in both new and used equipment at money saving prices. Fishing tools rented. Send for bulletins. Pressey & Son, Pueblo, Colo.

1 BUCYRUS—ERIE 36L Spudder, late model. Rig complete with tools and equipment. Cassel Drilling Co., Inc., Dumas, Texas. Phone WE 5-5019 or WE 5-4369.

LARGE QUANTITY used steel plates at attractive price. Will sell any amount. Write West Ohio Pipe Co., P. O. Box 193, Lima, Ohio; or phone CA 6-0821.

AMPHIBIOUS MUSKEG tractors. The famous BOMBARDIER product over 11,000 units produced to date. 9 models, unlimited variations. Symington of Seattle, 4603 Union Bay Place, Seattle 5, Washington.

FOR SALE: New steel mud tanks with V-bottom and pump for jets; sliding doors for mud leveling with expanded metal folding walkways, has 4½" drillpipe for jet lines on top of both sides. Overall dimensions 6' high x 7'6" wide x 30' long. Call, write or wire: Central Tool & Supply Company—MAin 4-6651, Liberal, Kansas or CEntral 2-6318, Oklahoma City, Oklahoma.

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at ESSO REFINERY Balto., Md.

BLOWERS Cent. 28,000 CFM at 17 Psig.
COMPRESSORS, Clark Gas RA-5; Clark Cent. 7,860 CFM 2 Stage
CONDENSERS 7,500 to 100 sq. ft.
REBOILERS 2,700 to 450 sq. ft.
HEATER TUBES Chrome 4" to 6" O.D.

FLUID COKER 10,000 BBL./DAY

PRESSURE VESSELS 3' to 12' Dia.
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8—OVERSTOCKED NEW GARDNER-Denver compressors for sale 30% off new price. Industrial Suply Company, Wichita Falls, Texas.

ARMY SURPLUS drilling and pumping equipment AW steel cord, and B. V. belts sent postpaid—B68, 60c, B112, $2.00, B144, $2.25: Many other items. J. B. Reed—Fredericktown, Ohio.

NATIONAL IDEAL MUD PUMP—Model C-150-B 7¼" x 12", 12 sheaves, skid mounted with LeRoi 8D-2000 engine. Ready to work. In yard at Carrizo Springs, Texas. TRAVIS DRILLERS, Inc., P. O. Box 1097, Austin, Texas. Phone GR 2-3422.

LATE MODEL trailer mounted double drum rotary drilling rig ideal for 3,000 or 4,000 foot drilling or 8,000 foot workover. Complete, ready to work reasonably priced. R. A. Tidwell, Oklahoma City, Oklahoma. Box 4423, OR 7-4949.

5,000' 4½" GRADE E Full Hole Drill Pipe, Hughes Flash Welded Hardbanded Tool Joints, $1.75 per ft., located at Duncan, Okla., Call CE 2-6318 Oklahoma City, MAin 4-6651, Liberal, Kansas.

1-7¼ x 10 Gardner-Denver Pump, good condition, WAK motor mounted, $8,000. Call CE 2-6318, Okla. City, MAin 4-6651, Liberal, Kansas.

EQUIPMENT WANTED

NEED 40' x 60' sectional steel building, 10' sides. Must be in No. 1 condition. Phone 1711—Bristow, Oklahoma or write P. O. Box 658—Bristow.

HELP WANTED

PARTY CHIEF FOR LIBYA—Must have 3 to 5 years experience as party chief and must also be experienced observer. Send snapshot and resume to P. O. Box 1262, Dallas 21, Texas.

GRADUATE CHEMIST or chemical engineer with at least four years refinery experience. Must be capable of supervising laboratory for a modern refinery in mid-continent area. Our employes have been informed of this advertisement. Box L-824, The Oil and Gas Journal, Tulsa, Oklahoma.

SALES REPRESENTATIVE

Atlas Powder Company requires a representative to sell and service the sale of corrosion inhibitors and desalting compounds to petroleum refineries on the East Coast of the United States including Ohio. Prefer man with both sales and processing experience who knows the Eastern refining industry.

Excellent growth opportunity with an expanding company; many fine benefits. All replies will be considered confidential. Send resume of experience, qualifications and salary requirements to:

Aquaness Department, Section R

Atlas Powder Company

P. O. Box 21072

Houston 26, Texas

HELP WANTED

HELP WANTED

NATURAL GASOLINE PLANT ENGINEER

Oil Company has immediate need for a qualified man with chemical and/or mechanical engineering degree. Require at least five years experience in all phases of natural gasoline plant operation and treatment of sour gas. Duties involve general plant engineering including laboratory control testing, plant performance tests, and plant maintenance. All inquiries held confidential. Please send resume of background and experience to Box L-818, The Oil and Gas Journal, Tulsa, Oklahoma.

NEW OIL JOB Directory, foreign and domestic, showing where to apply for jobs. 500 selected producing, refining, butane and pipeline companies. Nationwide. $5.00 cash. List Aircraft mechanics' schools—$3.00. OIML Co., Box 2603, Tulsa, Oklahoma.

PROCESS ENGINEER WANTED: Leading manufacturer of gas treating equipment needs experienced engineer to participate in design of gas processing systems. Submit detailed resume to Box L-830, The Oil and Gas Journal, Tulsa, Oklahoma.

PLANT CHEMIST, to age 40, with at least 5 years refinery or gas processing plant experience. Must be capable of supervising laboratory for gas processing plant with catalytic reformer, and thoroughly familiar with gas chromatography and CFR knock machine. Location South Louisiana. Salary commensurate with experience. Submit summary of experience, recent photograph, and salary expected in first reply. Box L-804, The Oil and Gas Journal, Tulsa, Oklahoma.

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LEGAL

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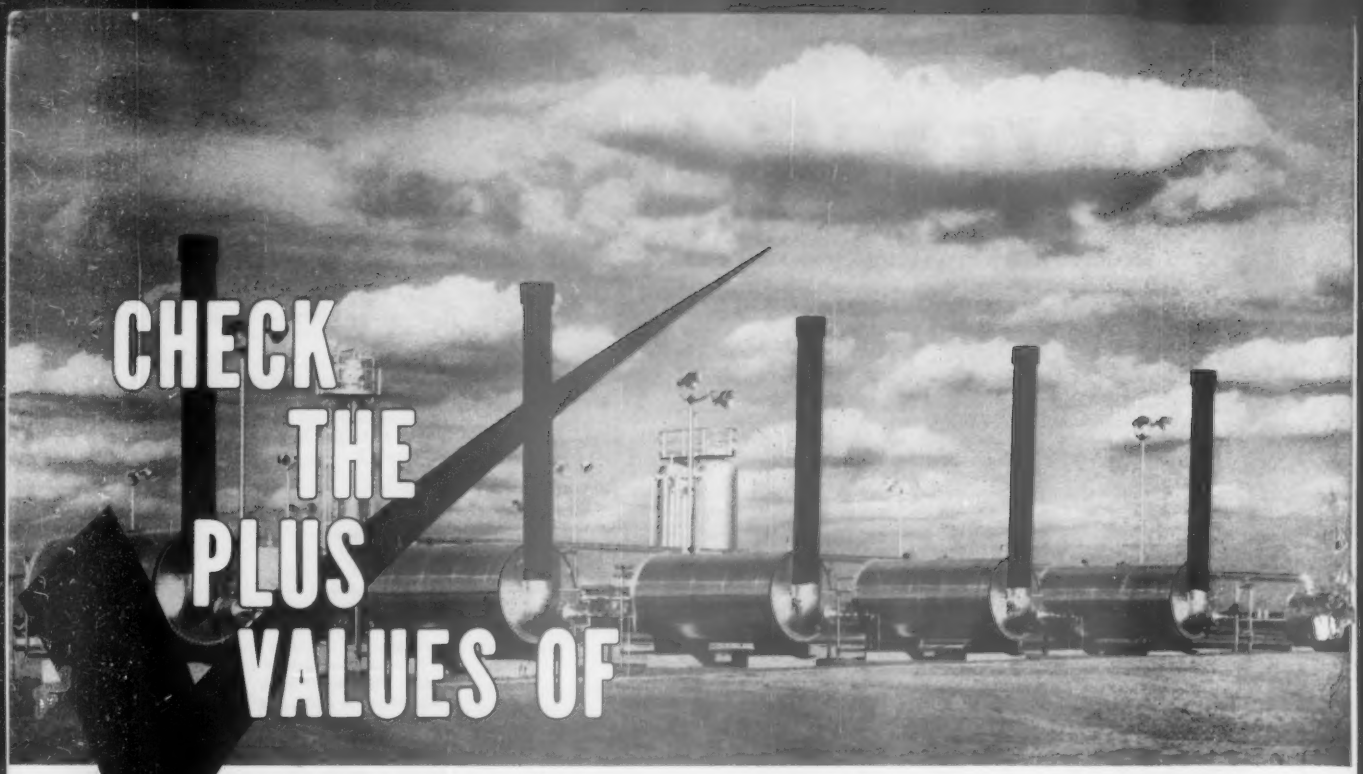

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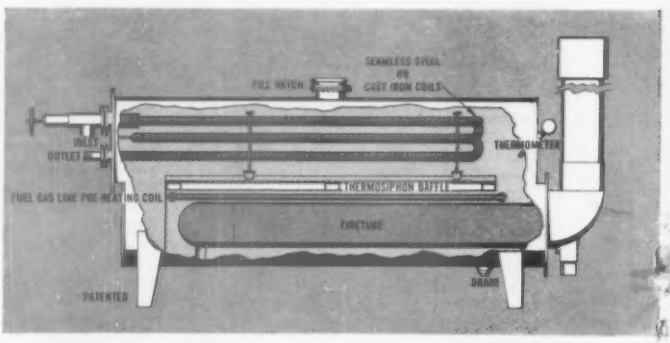

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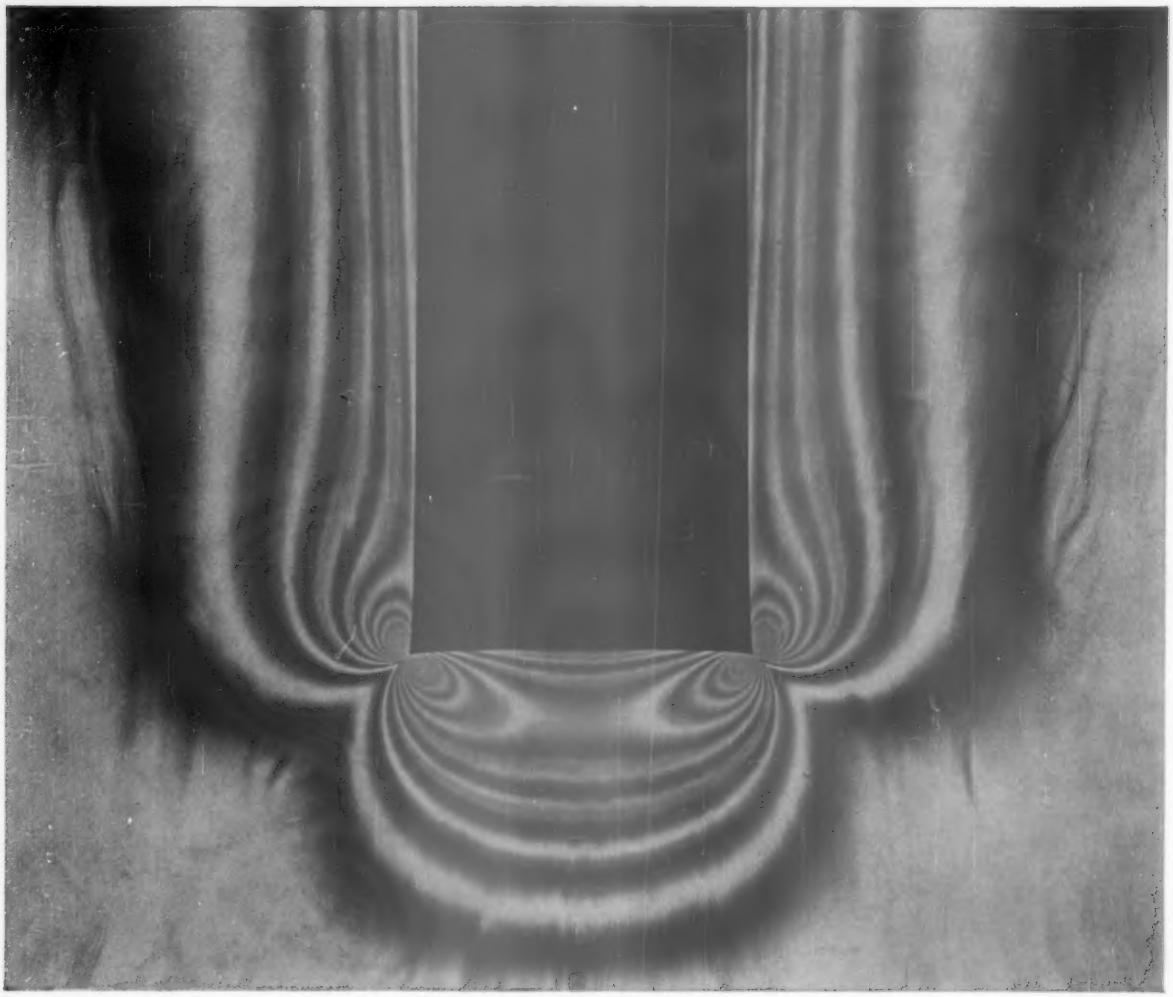

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